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NEW SERIES
VOL. LXIII, No. 1638

FRIDAY, MAY 21, 1926

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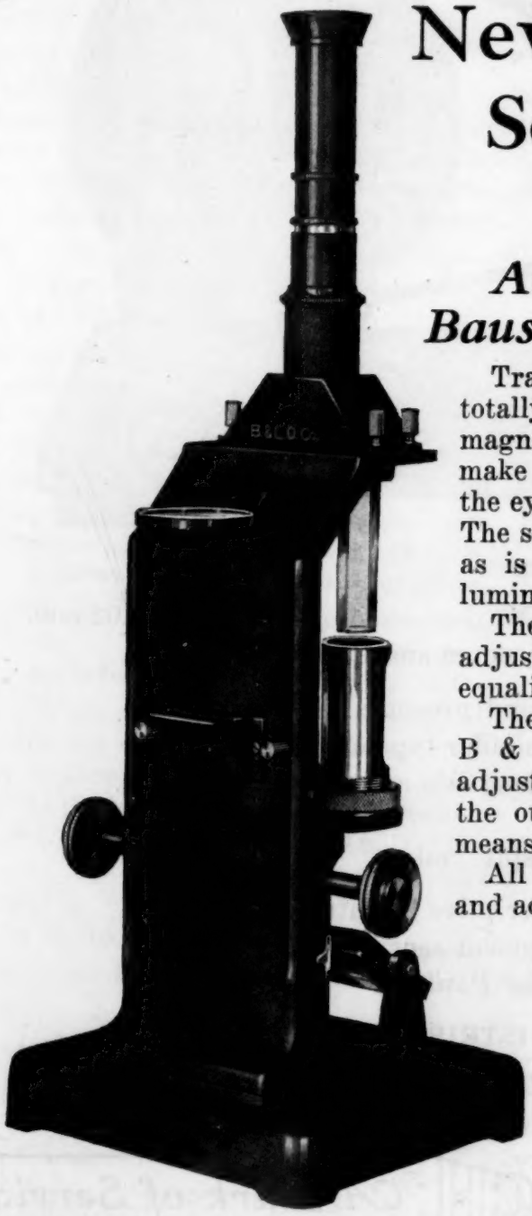

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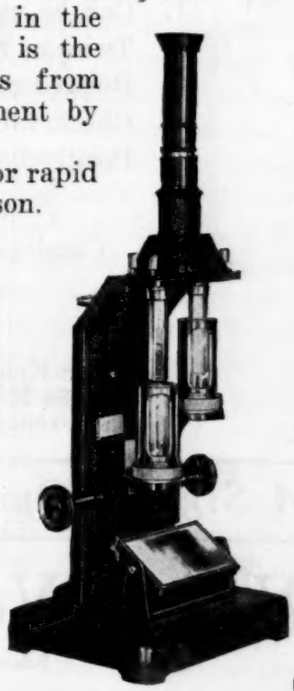

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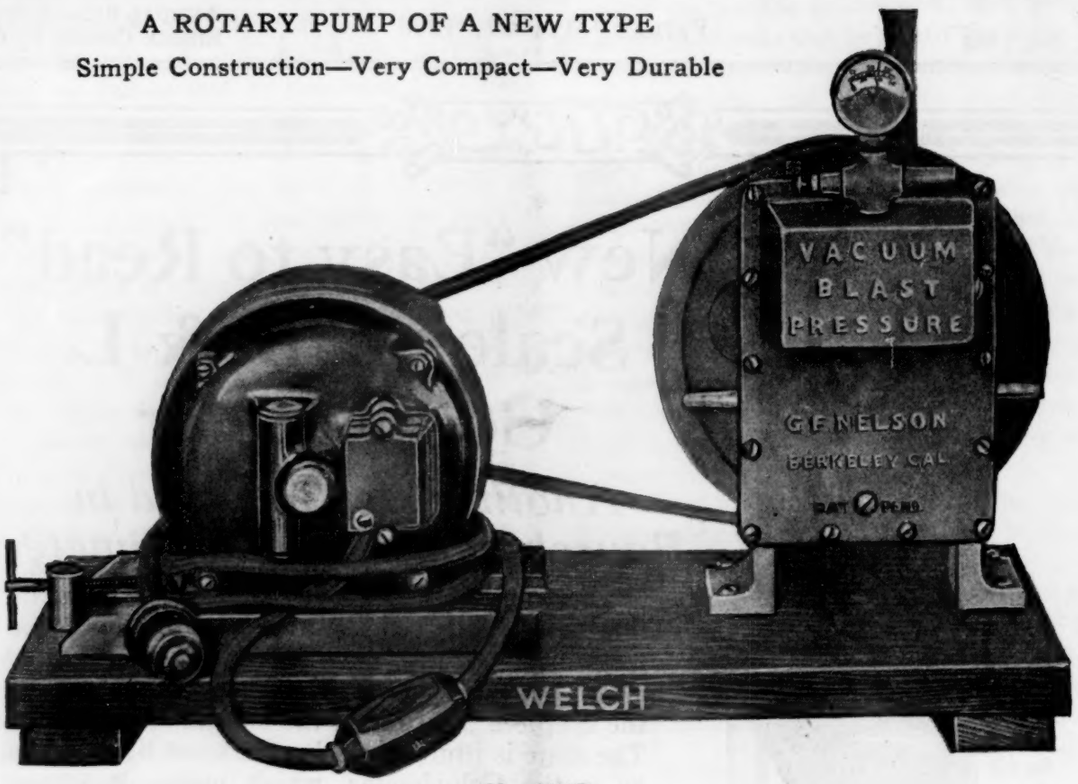


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**SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by**

**THE SCIENCE PRESS**

**Lancaster, Pa. Garrison, N. Y.**

**New York City: Grand Central Terminal.**

**Annual Subscription, $6.00. Single Copies, 15 Cts.**

**SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.**

**Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 8, 1879.**

## ARTHUR ROBERTSON CUSHNY AND PHARMACOLOGY

ON the evening of February twenty-fifth Arthur Robertson Cushny, apparently in robust health, was stricken down at the comparatively early age of sixty by a rapidly fatal cerebral hemorrhage. He was the fourth son of the late Reverend John Cushny, of Speymouth, Morayshire, Scotland, and was educated at Aberdeen University where he graduated M.A. in 1886 and bachelor of medicine and master of surgery in 1889. In the autumn of that year, having won the Thompson fellowship, he entered at Berne the laboratory of the physiologist, Hugo Kronecker, a former assistant of the great physiologist, Carl Ludwig, of Leipzig, for a year's further training in the methods of physiological research. I also had gone to Berne, to work in the laboratory of the distinguished biochemist, v. Nencki. The laboratories in which we two worked were far apart, that of Kronecker being distant from the medical quarter, and so we became barely acquainted in that year. Little did either of us foresee in those days that the future would bind us closely together and that both of us would take up pharmacology as our life work. After his year with Kronecker, Cushny went to Strassburg for a year's work with Oswald Schmiedeberg, at that time the outstanding figure of pharmacology in Europe. After a year's work at Strassburg young Cushny was appointed to an assistantship (1892–93) in the laboratory of Schmiedeberg. This eminent scientist, trained in physiology in the school of Ludwig, as also in the chemical laboratories, had early won the esteem of Ludwig by his masterly analysis in 1870, in the Leipzig laboratory, of the action of muscarine and nicotine on the nervous elements of the amphibian heart. Once on my alluding to Schmiedeberg's newly published "Grundriss der Arzneimittellehre" Ludwig summed up the man in the words, "Ach, der Schmiedeberg, das its ein Genie." It was he more than any other one man, who following in the footsteps of his teacher Buchheim, at Dorpat, turned the age-old materia medica and therapeutics of our medical schools into the modern and fundamental science of pharmacology. The development of this science is intimately connected with that of physiology and chemistry, but here reference can only be made to its connection with the former science. The experiments of Magendie, of Johannes Müller and later of Tiedemann, Gmelin, Bernard and many others, although undertaken to elucidate physiological problems, really laid the foun-

dation of pharmacology. Even as long ago as 1813 Magendie had found that the blood has the power of taking up and carrying metallic poisons, and by the middle of the century the doctrine of the "action of poisons by sympathy" had received its death blow. About the middle of the century, too, the now classic experiments of Claude Bernard and Köllicker, proving that the paralyzing action of curari centers in the end plates of the motor nerves, called attention to the value of toxic substances in physiological analysis. In the sixties and seventies there followed a succession of important discoveries by pharmacologists and physiologists in relation to the physiological action of important alkaloids, such as atropine, pilocarpine and many other substances, on the various organs of the body.

It was such experiments as these that induced Buchheim and others to insist on the insufficiency of the mere bedside study of medicines, and led to the erection of special pharmacological laboratories in which experimenters can build up their science, undisturbed by the intrusive demands of practical utility. Applied pharmacology or practical therapeutics as distinguished from a laboratory science must be the concern of men with bedside training and experience, and in many universities, more especially in England, we find professors of therapeutics on the same faculty with pharmacologists. The first laboratory devoted especially to pharmacology anywhere in the world was that of Buchheim in Dorpat in the early fifties. This graduate of Leipzig (1845), a pupil and assistant of the famous anatomist-physiologist, Wilhelm Weber, at Leipzig, was given the very inclusive chair of materia medica, dietetics, history of medicine and medical literature at Dorpat in 1849.

In the early eighties many young men, who were not consciously planning to become pharmacologists, entered the laboratory of Schmiedeberg not only because he was known to be a sound physiologist in all questions pertaining to the action of chemical substances in the animal economy (pharmacology) and a master of chemical and biochemical technique, but also because of his many notable discoveries in biochemistry. We were filled with admiration over the steady stream of important researches that emanated from him and his pupils. There were the various digitalis and other glucosides, muscarine, and various alkaloids that had been disentangled from unpromising mixtures, there were the researches made by perfusing organs or treating minced tisues with simple well-known chemical substances such as benzoic acid, benzyl alcohol and salicylic aldehyde that were published under the title "Oxidations, Cleavage and Synthesis in the Animal Organism," and many additional papers on these subjects by his pupils. The first clear proof, for example, that oxidations and syntheses in the animal organism are effected by soluble ferments was brought out under Schmiedeberg's leadership. Small wonder, then, that Cushny also sought out this man for inspiration and further training.

The next step in Cushny's career takes us to Ann Arbor. In the spring of 1893 I accepted the chair of pharmacology in the Johns Hopkins Medical School and in June when I left Ann Arbor to spend the summer in work at Berne, Dr. V. C. Vaughan, then the dean of the school at Ann Arbor, with the sanction of his medical faculty, commissioned me to find in Europe a pharmacologist to take the full-time post at Ann Arbor which I had just resigned. My thoughts at once turned to young Cushny. On arriving at Strassburg and after consulting with the old master discussion and persuasion began. Cushny had planned to return to England for a medical career of combined research, consultation and hospital work, something like that of the late Sir Lauder Brunton, then at the height of his fame. Schmiedeberg and Brunton had known each other in their early days, with Ludwig, I think, but the former always deplored the loss to pharmacology when Brunton was forced by circumstances to devote himself to practice. He remarked once, waving his hand in characteristic fashion, "Der Brunton hätte schöne Sachen machen können."

In urging Cushny to try a full-time post in pharmacology I pointed out to him that he could return to England in a year or two in case a life devoted entirely to teaching and research failed to satisfy him. It was with keen pleasure that I was able to cable Dr. Vaughan on the evening of my second day at Strassburg that Cushny would go to Ann Arbor. And so the young Aberdonian of twenty-seven, who was later to attain an almost unrivalled position in physiological pharmacology, came to this country and gave it twelve fruitful years full of inspiration to others. It was at the University of Michigan that he brought out in 1899 the first edition of his masterly and comprehensive treatise on pharmacology with the subtitle, "The Action of Drugs in Health and Disease." The treatise was built on the general plan of Schmiedeberg's "Grundriss," but with more detail and with more attention to the therapeutic neeeds of the physician and with such alterations in the Buchheim-Schmiedeberg classification of drugs as are inevitably induced by the personal equation. It was dedicated: "Dem Meister, vom Schülergewidmet." It was the first severely critical, rigorously scientific and hence really authoritative general text-book to be written in English by an experimental pharmacologist. In a critical review of the fourth edition of this work in 1906, I wrote:

> To undertake the task of writing a comprehensive treatise on pharmacology calls for courage; actually to

complete the enterprise requires also sound judgment, industry and learning. No teacher can read the articles on the action of alcohol, ether and chloroform, to cite only a few examples, without a feeling of gratitude toward Professor Cushny for presenting to medical students so good a digest of these topics. There is every evidence throughout the book that its presentations are based on first-hand knowledge of original papers and monographs of importance. More than this, Cushny's activity as an investigator has qualified him in an eminent degree to sift the wheat from the chaff.

The work is now in its eighth edition and it is not too much to say that it has had an enormous influence on the development of pharmacology in the English-speaking world.

Cushny, however, was not content with writing a notable text-book. To him was also given the power of being able to bring out from the darkness of the unknown new facts of great importance and correlating them with existing knowledge. While thoroughly appreciating the importance of the chemical side of pharmacology and familiar with its achievements he elected, in consequence, no doubt, of his early training at Aberdeen and Berne, and wisely, as the future showed, to devote himself to the physiological and clinical aspects of the science. Succinctly stated, his discoveries lie in the domain of the action of drugs and other chemical substances on the organs of the body, and they have become, almost without exception, of prime importance for the physiological and medical sciences. Already at Strassburg, stimulated by Schmiedeberg, he had begun his studies on the action of digitalis and other glucosides, that so profoundly affect the entire circulatory apparatus and certain of the nervous structures that control the action of its individual parts. Admittedly, the action on the heart and its inhibitory mechanism is the most significant of all the effects of this very important class of therapeutic agents. It was natural for a man of Cushny's insight into what is worth while to attack this central problem with vigor and pertinacity. In a series of papers which must always remain models of their kind, he first clearly enunciated the main issues and first correctly classified the various stages involved in the action of digitalis on the mammalian heart.

It was at Ann Arbor that his most important discoveries in this field were made. His early observations are described in a paper entitled "Action of the Digitalis Series on the Circulation,"[1] appearing in 1897, and from this time up to the appearance of his valuable monograph in 1925 entitled, "The Action and Uses in Medicine of Digitalis and Its Allies," he published many papers dealing with every phase of the subject, and there is scarcely any feature of the action of digitalis which he has not illuminated.

In 1899 appeared the paper[2] in which he first called attention to the similarity of the disordered mechanism of the auricles of the dog induced by faradic stimulation to certain disturbances of the heart seen at the bedside—later to be named by him auricular fibrillation. It may be of interest to recall the gradual evolution of our conceptions of clinical auricular fibrillation, a condition which will always be linked with Cushny's name. Though fibrillation of the ventricle in experimental animals had been known since 1850[3] it was not until the appearance of MacWilliam's paper[4] in 1887 that a similar condition of fibrillary contraction of the auricles following faradic stimulation was first briefly described. Cushny discovered (1897) that the digitalis bodies in the last or toxic stage of their action also not infrequently produced auricular delirium or fibrillation of the auricles exactly as does faradic stimulation. In the paper of 1899 just referred to dealing with the "interpretation of pulse tracings" Cushny states:

> A few words may be added in regard to the extreme irregularity of the heart known clinically as delirium cordis. It is necessary to explain that in physiology this term is used to indicate fibrillary contractions of the heart, which arrest the circulation and prove immediately fatal. The clinical sphygmogram in these cases resembles exactly that obtained from dogs when the auricle is undergoing fibrillary contraction, which may be continued for a long time without proving fatal. I do not wish to assert that the clinical delirium cordis is identical with the physiological delirium auriculae, but the resemblance is certainly striking.

Seven years later, in a paper with Edmunds,[5] entitled, "Paroxysmal Irregularity of the Heart and Auricular Fibrillation," he again emphasized the inferences of his earlier paper and stated his belief that the irregularity observed at the bedside is definitely an auricular fibrillation. This paper was the first to appear with the words "auricular fibrillation" as an integral part of its title, and it is interesting to note the constant and ever-increasing frequency of the use of this description in the subsequent literature of heart disease.

The diagnosis of Cushny and Edmunds, as Cushny has stated in his monograph on "Digitalis and Its Allies," was received with doubt by the various schools of investigators of disease of the heart, and efforts to

[1] *Journal of Experimental Medicine*, ii, 233–239.

[2] *Journal of Experimental Medicine*, iv, 327.

[3] Hoffa and Ludwig, *Zeitschrift für rationelle Medizin*, ix, 107.

[4] *Journal of Physiology*, viii, 296.

[5] *American Journal of the Medical Sciences*, 1907, n.s. cxxxiii, 66–67.

arouse interest in it were fruitless up to 1909, when the new electrocardiographic methods in the hands of Rothberger and Winterberg, Lewis and others demonstrated the correctness of his contention and showed that fibrillation of the auricles is indeed of frequent occurrence in cardiac disease. The late Sir James Mackenzie, a leading English authority, who held "that clinical observers are obsessed by laboratory discoveries," says, in his "Diseases of the Heart":

> When the full significance of the discovery of this condition [auricular fibrillation, earlier called "delirium cordis, paralysis of the auricle and nodal rhythm," at a time when its true nature was not understood][6] comes to be recognized, it will be looked upon as one of the most important discoveries not only in cardiology but in medicine; while its important pursuit continues to throw new light upon many clinical and physiological problems.

Throughout the succeeding years many other papers appeared from his pen dealing with the subject of cardiac irregularities but more especially with the problems involved in the pharmacologic study and therapeutic control of the fibrillating heart. For a period of thirty years the study of the effects of digitalis and other cardiac glucosides continued to occupy his attention, and his studies have made clear many obscure and confused ideas in relation to the pharmacological action of these important drugs and have greatly assisted in giving us a sound and rational conception of their therapeutic action. That the specific effect of digitalis in cases of auricular fibrillation in man depends entirely upon the direct action of the drug on the myocardium, without vagal effect, a view supported by Cushny, is however still a matter of uncertainty in the opinion of cardiologists of experience.

The study of the nature of the action of diuretics has necessarily occupied the attention of pharmacologists and very naturally they have been equally interested with physiologists in theories that have been advanced to explain the secretory activity of the kidney. At a time when most physiologists appeared to be inclined to accept the Bowman-Heidenhain view of vital secretion, Cushny published three papers presenting results which could be more easily interpreted on the reabsorption theory of Ludwig. He found that if sodium chloride and sodium sulphate are injected into the blood stream in such amounts that an equal number of anions are present, the excretion of the two bodies in the urine follows different curves and varies independently of the concentration of the salts in the plasma. He interprets this as due to a variation in the permeability of the tubules to sulphate and chloride, the latter being reabsorbed and the former not. On retarding the flow through the tubules by partial obstruction of the one ureter, results were obtained which appeared to confirm those mentioned above. Both the percentage and the absolute amount of water and chlorides secreted by the kidney on the obstructed side were found to be lower than on the normal side, while sulphates appeared on the obstructed side in greater percentage but in smaller absolute amount, decreased urinary volume being taken into consideration. This divergence in the percentile and absolute excretion of two simple inorganic constituents was attributed by Cushny to their differential absorption by the epithelial cells of the urinary tubules. The kidneys were also found to deal with both sodium phosphate and urea in exactly the same manner as the sulphate. After investigating also the changes in reaction of the urine during saline diuresis, he came to the conclusion that the formation of an acid urine from an alkaline plasma could be explained in accordance with the filtration-reabsorption view of Ludwig. "The presence of salts in the glomerular fluid which are capable of extensive hydrolysis and of which the cations can permeate the tubule, while the anion fails to do so in equal measure, and sufficient reabsorption in the real tubules" are the essential factors of acid secretion. Many years later, at University College, London, and at Edinburgh, he again took up urinary studies and published in 1917 and 1921 two papers dealing with other phases of the subject, which may be summarized as follows:

Many years before (1874) Heidenhain had shown that after the injection of indigo carmine into the blood stream of rabbits, following cervical section of the spinal cord, in order to annul urinary secretion, this dye accumulated in the epithelial cells of the convoluted tubule of the kidney, and he drew the inference from his experiments that this dyestuff is eliminated into the tubules by the "vital activity" of their cells. By analogy he inferred that urea, the main nitrogenous waste product of the body, is also excreted not by filtration through the glomeruli, as Ludwig had maintained, but by the "vital secretory action" of the tubular cells. Cushny proposed to himself to test Heidenhain's theory of urea secretion, employing the same experimental procedure with rabbits, but examining the tissues of the kidney in respect to their content of urea in place of their content of indigo carmine. Heidenhain had estimated the tubular content of indigo carmine by means of the microscope, while in Cushny's experiments the urea content of the kidney was quantitatively estimated by reliable chemical methods. After section of the spinal cord one kidney was removed immediately, and two hours later the other kidney was excised, ground up and its urea content determined. The kidney removed immediately after the section

[6] Insertion in brackets is mine.

of the cord contained rather more urea than the one removed two hours later. It was thus shown that no accumulation of urea occurs after the kidneys ceased to eliminate water, "and that the cells of the tubules are unable to accumulate urea either in their interior or in the lumen in the absence of a flow of urine."

Whether or not future experimenters succeed in substantiating Heidenhain's idea that indigo carmine is excreted by the tubular cells (in addition to the now accepted elimination through the glomeruli) it is nevertheless true that Cushny's experiments prove that the kidney deals in a different manner, under similar experimental conditions, with urea than with indigo carmine. Here, as elsewhere in science, analogy is found to be a dangerous guide. The determination by Cushny of the amounts of glucose present in the kidney after injection of phloridzin in experiments similar to those described above, led to the same results as were obtained with urea.

Cushny's next and last work on urinary secretion deals with that fundamental problem which has always intrigued pharmacologists, namely, to what extent the action of diuretics is localized in the kidney itself (in other words, in its own vascular, cellular and nervous elements) and how far it is brought about through alterations in the composition of the blood and functional alterations in the blood flow. In a paper with Lambie he studied the action of such diuretics as caffeine, strophanthin, the salines, urea and pituitary extract, estimating directly the renal blood flow by a modification of Barcroft and Brodie's method which avoids employment of the older and misleading oncometer. These experiments led him to conclude that pituitary extract is the only one of the many diuretics examined that appeared to act directly by increasing the blood flow through the kidney.

Cushny's original contributions on urinary secretion and on the action of diuretics are of less outstanding importance than those made in the other two main fields of his life work—the study of the effects on man and animals of the cardiac glucosides and of the pharmacological action of optical isomers. Fortunately for us, however, he was induced by Starling in 1917 to undertake the writing of a comprehensive monograph on the secretion of the urine. After the completion of the book, he wrote to Starling a letter in place of the usual author's preface, from which I may cite the following paragraph:

> The growth in the literature on the kidney has been extraordinary since the time when you and I began to work on it, and this increase in bulk has not gone along with an improvement of quality, but rather the reverse. No other organ of the body has suffered so much from poor work as the kidney, and in no other region of physiology does so much base coin pass as legal tender. It was therefore necessary to sift thoroughly this mass of printed matter of about 6,000 pages, and I have read it carefully and, as far as might be, sympathetically, though I must confess that my patience has been sorely tried by some papers in which the depth bore no proportion to the length. It soon became obvious that if each writer were to be dealt with faithfully, this would be, not a monograph, but a series of volumes, and the whole trend of the argument would be lost in a tangle of discussion.

In this monograph Cushny sifts and coordinates the mass of contradictory data that have accumulated since Ludwig's day, and modifies and reshapes the theory of that master into what he modestly calls "the modern theory." The "modern theory" may be briefly stated as follows: The glomeruli filter from the blood all the diffusible bodies of the plasma. This glomerular filtrate contains, therefore, all the non-colloid constituents in about the same concentration as they exist in the plasma. During the passage of this filtrate along the tubule, water and various constituents (threshold bodies) are reabsorbed, while other substances (non-threshold bodies) are concentrated more and more during their course along the tubule. The reabsorbed constituents with the water accompanying them constitute, as he thinks, a fluid of unvarying composition, approximately that of Locke solution. This theory then "accepts the general scheme of filtration and reabsorption of Ludwig, but, appreciating the inadequacy of the known physical forces, supplements them as far as is necessary by the 'vital activity' postulated by Heidenhain."

Cushny is quite conscious that any theory of urinary secretion advanced in our day can not claim finality. He himself says of this theory, "It is impossible at present to prove it correct . . . it is sufficient to show that it is in accordance with a large body of observations. Even if it fails to offer a complete explanation of these, it merely requires further development, not abandonment."

At this writing, the second edition of the book has not come to hand, but I have been led to believe that Cushny, like the true scientist he was, has been induced by the discovery of new facts, at the hands of others as well as by his own pupils, to modify his views in some particulars.

This excellent monograph with its coherent theory of urinary secretion has stimulated many younger investigators to attack problems in this field. Men who knew not Ludwig or Heidenhain have found it of great value to have the contributions of an earlier day analyzed and codified, as it were, by a man of

wide experience and sound judgment in the allied fields of pharmacology and physiology.

We come now to an entirely different aspect of Cushny's work, that dealing with the pharmacological behavior of optically active substances. Omitting here all references to the fundamental discoveries of Pasteur in 1845 and thereafter and to studies of a few observers in the early 80's and 90's in regard to the difference in the taste of pairs of isomers, we may pass at once to a brief consideration of certain physiological and pharmacological experiments antedating those of Cushny.

The first physiological experiments on the assimilation of optical isomers by the tissues of the higher animals were those made by Brion in 1898, who attempted to show that *l*-tartrates are oxidized more easily by the dog than the *d*-tartrates. These results were critically examined by Neuberg and Saneyoshi twelve years later, who prove that *l*- and *d*-tartaric acids are assimilated with equal ease in the tissues, which appear to be unable to differentiate between them. The many observations made along these lines since Brion's can not be entered upon here. Suffice it to say that an extensive literature now exists in regard to the preferential utilization by the tissues of higher animals and by lower organisms of isomers among sugars, organic acids, camphors, alkaloids and many other compounds, much of which has been adequately reviewed by Cushny in his Dohme Memorial Lectures of last year, now appearing as a monograph entitled "Biological Relations of Optically Isomeric Substances," published for the Johns Hopkins University by the Williams and Wilkins Company, of Baltimore.

After these earlier experiments there soon followed pharmacological observations by Chabrie (1893), who compared the toxicity of *d*- and *l*-tartaric acid by injecting them into the peritoneal cavity of experimental animals and found a difference between the two isomers, but Cushny holds that death here was not due to the optically active portion of the molecules but to their hydrogen ion and that "the supposed difference in toxicity was purely casual." Cushny criticizes many of the toxicity determinations, effects on serum reaction, blood clotting, etc., with the four tartaric acids that have been done since 1910 as being quite valueless, since the supposedly essential tartrate action is complicated by the vastly more powerful one of the hydrogen ion.

In 1904 Pictet published observations made by Mayor, who states that *l*-nicotine, the natural alkaloid, is twice as poisonous as *dl*-nicotine and that the former also causes greater local pain and more violent convulsions than the latter, but Cushny evidently regards Mayor's work as needing corroboration, as he says of it, "it would be desirable to repeat these experiments." It will thus be seen that the earlier pharmacological experiments with isomers are probably more open to criticism than the earlier and later experiments with fermenting organisms and the earlier and later biochemical studies, since they suffered such grave defects in technique that no conclusions of lasting value can be drawn from them.

The first definite example of distinct and measurable pharmacological differences in the action of two optical isomers falls to the credit of Cushny, who published the results of his earlier studies in 1904. Pure *l*- and *dl*-hyoscyamine (atropine) were at first used and it was found that the two bases are equally poisonous to many organs of the frog, such as the heart, muscle and nerve ends, but that the *dl*-form is more excitant for the central nervous system than the *l*-form and that this action is more persistent. It was found that in mammals many organs were unaffected by even large doses of either isomer, while certain organs, such as the heart and central nervous system, react to the same degree to the two isomers, but in the case of other structures the *l*-hyoscyamine is almost twice as powerful as the *dl*-form. This last ratio held true for all the specific pharmacological actions of the "tropeines" in the dog, as evidenced, for example, in the myoneural junctions of the motor oculi and in the adenoneural junctions of the submaxillary glands. The same ratio also held for the intestines, but it is thought doubtful whether the action of these alkaloids on smooth muscles is exerted solely on their hypothetical myoneural receptors, as is more clearly the case with their action on the receptors of the heart, iris and ciliary body.

The specific action, then, as Cushny first demonstrated, of *l*-hyoscyamine on many organs is twice as great as that of *dl*-hyoscyamine, and as two molecules of atropine (*dl*-hyoscyamine) contain one molecule of *l*-hyoscyamine and one of *d*-hyoscyamine Cushny stated his results in the following simple form:

$$2\ dl = l + d \text{ chemically}$$
$$2\ dl = l \text{ pharmacologically}$$

Cushny's first conclusion was evidently that the *d*-isomer is practically devoid of action on the myoneural junctions of the autonomic system, but further experiments, in which the pure *d*- and *l*-isomer were compared directly with each other in place of the *l*- and *dl*-forms, led him to modify slightly his statements. Both isomers were now found to act qualitatively in the same manner, but the *l*-form acted in general about twenty times as strongly as the *d*-form except on the central nervous system, in which the *d*-form caused a distinctly greater and longer excitation than the *l*-form.

Similar observations were made with *l*-, *dl*-, and *d*-hyoscine and with the *l*-, *dl*-, and *d*-homatropines on the cardiac inhibitory, oculomotor and secretory peripheral nerve terminations. In experiments in which the *l*- and *d*-hyoscines were compared directly it was found that the *l*-base acted sixteen to eighteen times as strongly as the *d*-base on these organs and this ratio also held for their action as antagonists to pilocarpine on the intestines. Recently, according to Cushny, Moir has shown, while studying the efficacy of *d*- and *l*-hyoscine in "twilight sleep," that *d*-hyoscine has little or no effect on the central nervous system in man, while the *l*-isomer is efficient. In the case of the homatropines it was found that the ratio of the activity of *l*:*d* on the autonomic terminations is about 5:8, that is, the *l*-isomer is approximately only twice as powerful as the *dl*.

After Cushny had shown that natural laevo-rotatory alkaloids, such as hyoscyamine and hyoscine, are distinguished by quantitative differences in their action on the nerve terminations of the autonomic system he next studied the behavior on the animal body of the isomers of the then recently synthesized adrenalin, or epinephrine of our pharmacopoeia. Shortly after the synthesis of *dl*-epinephrine was effected by Stolz in 1904, Biberfeld stated that this isomer is exactly equivalent to the natural *l*-base, as prepared from the medulla of the suprarenal glands, in respect to their action on blood pressure, on the pupil of the enucleated frog's eye, and in causing glycosuria in animals.

Cushny at first, in repeating the work of this investigator, confined himself to an examination of the relative activities of *l*- and *dl*-epinephrine on the myoneural junction in the arterioles, measuring their action by means of blood pressure estimations. He was able to show that Biberfeld was in error and that the natural or *l*-base raises the arterial pressure nearly twice as much as its synthetic *dl*-isomer, and he concluded that the *d*-isomer (then not obtainable) is devoid of action. Later he had the opportunity to compare *l*- and pure *d*-epinephrine (Flächer) directly and found that the *d*-base has an action qualitatively similar to its *l*-isomer but that the latter acts about 12–15 times as strongly as the former on the sympathetic terminations controlling the glycogenic function of the liver, and further "that the relative minimum lethal doses of the two isomers appeared to be of the same order of magnitude but could not be ascertained so accurately." All these results were soon confirmed by Abderhalden and his pupils, by Tiffenau and others.

The fundamental observations of Cushny in respect to the pharmacological action of isomers was soon followed by the studies of other investigators who have examined the pharmacological action of a large number of isomers of the cocaine series, of coniine, tetrahydroquinaldine, camphor, hydroxyhydrindamine, tetrahydro-β-naphthylamine, the canadine methochlorides and other compounds. The findings of these workers are given in concise form by Cushny in the monograph above referred to.

So much for Cushny's fundamental researches on optical isomers, so suggestive and stimulating to others. In conversations with me he has repeatedly expressed his conviction of the ultimate very great importance of continued research in this field, an opinion that will be shared, I believe, by all students of the biological sciences. In an inaugural sessional address delivered before the North British Pharmaceutical Society in 1919, he said.

> This optical activity is, in fact, the most persistent evidence of life which we possess. An optically active alkaloid or acid may be kept for centuries after the plant which formed it and the chemist who isolated it are dead, but it will still possess its optical activity, testifying that it was formed by some living thing either directly or indirectly. When we find an optically active substance in the earth, we may know at once that it arose through the agency of life. The petroleum we burn, for example, must have arisen from living tissues, for it is optically active. Not only is it the most persistent sign of life, but it is the most definite physical characteristic of life. No other can be measured in actual numbers in the same way.

The specialist will find in Cushny's monograph on optical isomers, in which his unrivalled judgment and wide knowledge are brought to bear on the general aspects of pharmacological action, whether induced by optical isomers and ferments or other principles, an analysis, extending over about thirty pages, of the influence of chemical configuration and constitution on pharmacological action, with illustrations drawn from various older as well as more recent sources. To cite an example, in considering the specific activity of such a drug as hyoscyamine, he points out that three factors have to be taken into account:

> (1) The general structure of the molecule, which is a tropine ester, preferably of an aromatic acid, and which gives a slight activity as a general rule; as a type phenacetyltropine may be taken, (2) the presence of alcoholic hydroxyl in the side chain of the acid, which intensifies the activity to a pronounced extent; for example, atropine, possessing OH, is some 200 to 300 times as powerful as hydratropyltropine which is devoid of it, and (3) the presence of an asymmetric carbon, which gives optical rotation to the molecule, and may vary its activity about 15 to 20 times according to the direction of that rotation.

Space forbids a further elaboration of these factors or to what extent in enzymic or other biological reactions it is "the configuration of the whole molecule,

rather than the presence of individual radicles, that is the determining factor." Cushny concludes that the analysis he has given "of the reactions of enzymes and substrates, of receptors and drugs, far from clarifying the relation of living matter and chemical constitution, indicates that more factors are involved than are generally recognized and that very slight changes in chemical structure may alter enormously the reaction between them. Such investigation discourages such crude rules of the relation of chemistry and therapeutics as have often been laid down and shows how far we have still to travel before we begin to understand the chemistry of life."

In the above account of the relation of optical isomers to biology I have entered into some detail because of the importance of such investigations not only to chemists but to biologists in general, and I have drawn freely in the foregoing statements on Cushny's original papers and on his monograph.

Cushny's work in the field of the isomers of alkaloids and of the cardiac glucosides will remain, I think, in days to come his outstanding contribution to science and medicine.

Numerous other contributions to pharmacology were made by Cushny. Since 1891 papers have appeared that deal with the action of chloroform and ether, the active constituents of gelsemium, of muscarine, cocaine, sparteine, piperidine and some of its compounds, the saline cathartics, ricin, alcohol, calycanthine, oxidizing salts, nutmeg and the senecio alkaloids. He also occupied himself with problems concerning the uterus, the respiration, exhalation of drugs by the lungs, the action of serum, the nature of antagonism, and in addition wrote a valuable pamphlet in defense of vivisection and extensive articles on the nitrites, the members of the atropine group and ergot for Heffter's "Handbuch der experimentellen Pharmakologie."

I shall here refer to one only of the above-mentioned papers, as it involves a matter of great economic importance for animal industry. In the paper on the *Senecio family,* Cushny, working with pure alkaloids, confirms the views of previous investigators who had already demonstrated by feeding experiments that a fatal disease affecting horses and cattle and characterized by hepatic cirrhosis, known in New Zealand as Winton disease, in South Africa as Molteno disease and in Canada as Pictou disease, is really only chronic poisoning with these alkaloids.

In 1905, Cushny, to the lasting regret of his many friends and admirers in this country, resigned the chair of materia medica and therapeutics at the University of Michigan to accept the chair of materia medica and pharmacology at University College, London; here he remained until 1918, when he was elected to the chair vacated at Edinburgh by the death of the distinguished Sir Thomas Fraser. "At University College he had to undertake the creation of a department out of nothing," as his former colleague, Professor Starling, has written, "the quarters of his predecessor consisting simply of one ill lit and badly furnished room—when at last, through a generous gift of Mr. Carnegie, it became possible to provide Cushny with a laboratory adequate to his work, we hoped that we had secured his continued and permanent help in building up the school of our ambitions. But to an Aberdeen man the old reputation of a professorship at Edinburgh University was too strong to be resisted and the succession to the chair of Fraser seemed a fitting crown to his life's work." And at Edinburgh he remained until his untimely death a few weeks ago.

At both British centers of learning he continued to carry on his research work, remodeled the teaching, instilled a new spirit into pharmacology, collected about him a number of able young men, some of whom, influenced by his unusual personality, elected to enter upon a life of combined teaching and research work and now hold important chairs of pharmacology in England and the dominions.

Cushny returned to England at a time when English pharmacology, so long taught and pursued as a separate science on the continent, had not reached its present position. A number of younger men, to be sure, who have since become eminent were then teaching the subject and trying themselves out in it, but the older generation, although men of undoubted ability and with many fine achievements to their credit, were after all too much absorbed with the details of medical practice to do full credit to themselves in an exacting science that calls for a more modern and fundamental training, such as only men of a later day can secure. It is easily understandable that, returning to England at this time, a man of Cushny's type, with his unrivalled experience and already high reputation, his sound judgment of men and matters scientific, his kindly and sympathetic nature, and above all a man devoid of ostentation and one who taught by precept and example, could do more than any of his contemporaries to put English pharmacology in its present high place.

I have written above as one man may write of another's life work in a science to which both have been devoted. But there is a word more to be added. We were friends for thirty-seven years. During this time scores of letters passed between us concerning our own researches or those of others, the affairs of the journal in the editorship of which he assisted me, the work of international committees on which we were serving and many other matters of mutual interest. On his recent visit to this country we were

planning, indeed, a new venture in the interests of our science.

With Cushny's death there was lost to humanity a striking example of a life devoted to high and unselfish purposes. Only those bound to him by ties of blood can mourn his passing more than does the writer.[1]

JOHN J. ABEL

JOHNS HOPKINS UNIVERSITY

## THE DEPARTMENT OF TROPICAL RESEARCH OF THE NEW YORK ZOOLOGICAL SOCIETY

FOR nine years the New York Zoological Society has maintained this department, and the year 1925 has been the most successful. Three important undertakings are given in the résumé below:

First, the Arcturus Oceanographic Expedition, which left New York on February 10, 1925, and returned July 30, having carried on work in the Sargasso Sea in the Atlantic and in the waters about Cocos Island and the Galapagos Archipelago in the Pacific. Months of careful preparation were devoted to the selection of the staff and the outfitting of the converted freighter, the *Arcturus,* which was given to the society by Mr. Henry D. Whiton. The greater part of the financial burden was undertaken by Mr. Harrison Williams, and Messrs. Marshall Field, Vincent Astor, George Baker, Jr., and other gentlemen also contributed generously.

While a certain amount of shore work was done at the islands visited, our activities were confined almost exclusively to the fauna of the deep sea and of the shallow waters around the islands. Special attention was given to the study of the habits of littoral fishes, work which was much facilitated by the use of a copper diving helmet; the luminescence of deep sea animals was a vast and intensely interesting field of research, in which some remarkable problems were worked out, while the locomotion and distribution of various forms and the study of larval fish yielded important results.

We were so fortunate as to be present at a volcanic outbreak on Albemarle Island, in the Galapagos, of which splendid moving pictures were obtained, and chanced upon an extraordinary current rip in the Pacific which teemed with fish, birds, mammals and even reptiles, as well as incredible numbers of invertebrates.

We returned to New York with large collections, including many new species of deep sea fish, tremendous quantities of plankton, seven hundred photographic negatives, eleven thousand feet of excellent moving pictures and about four hundred colored plates made from living oceanic creatures. Since that time an elaborate exhibit of specimens, apparatus, photographs and paintings has been held at the American Museum of Natural History, and Miss Cooper has held exhibitions of her paintings in Chicago and Washington. Over fifty lectures have been given by myself and Ruth Rose throughout the country and fifteen articles have been published in the *Zoological Society Bulletin* and other magazines. Many collections have been prepared for technical study, and some are now being worked over by specialists.

A volume, "The Arcturus Adventure," has just appeared, treating of the expedition from the same popular angle as the book published by Putnam's two years ago, "Galapagos: World's End."

A gratifying result of the two expeditions—one on the *Noma* in 1922 and that of the *Arcturus* in 1925—has been the interest which they have awakened in others to carry on work near the Galapagos. I was able to give some assistance to Mr. Harry Payne Bingham for his oceanographic trip in the *Pawnee* to the Caribbean, which aroused his enthusiasm to such an extent that he has now built a ship specially for such work. Mr. William K. Vanderbilt, who has just returned from an oceanographic expedition to the Galapagos on the yacht *Ara,* drew upon our experience in the outfitting of his ship and in methods of collection, and has brought back many interesting specimens for identification and study. Zane Grey consulted with me concerning the big-game fishing trip which he afterward made to the Galapagos on his schooner *Fisherman* and concerning which he has since published an interesting volume.

Four United States cruisers visited the Galapagos on their way home from Australia, and Commander Kalbfuss sent me an account of the volcano, which in late September was still in eruption, together with airplane pictures of the lava pouring into the sea.

The most unexpected result of the *Arcturus* expedition was the great interest which it aroused, not only in this country but abroad. The only direct outside articles about it appeared in the New York *Times,* consisting of wireless accounts, and more detailed stories which were sent by mail as opportunity offered.

The second part of the year's work falls under the head of the zoological work by the department dealing with the fauna of Kartabo, British Guiana. For parts of eight years my staff and myself have engaged in intensive study of a quarter of a square mile of jungle in this rich field. During the past year more has been published concerning it than in

[1] The reader will find a complete bibliography of Dr. Cushny's writings in the April issue of the *Journal of Pharmacology and Experimental Therapeutics.*

any preceding one, which is particularly gratifying when the contemporary labor of the *Arcturus* is considered. Five important technical papers have appeared in *Zoologica*, the society's publication, consisting of monographs on the "Ecology of a Quarter of a Square Mile of Jungle," the "Variegated Tinamou," "the "Membracidae," the "Termites," and the "Isopods." These form one complete volume of *Zoologica*, Volume VI, containing over five hundred pages. A volume of popular essays, "Jungle Days," has also been published by Putnam's, while additional monographs on the life history of the three-toed sloth and the fish of Kartabo are already in type.

Among other gifts, fifty Isopods, including two types, and five hundred and eighty Lepidoptera have been given to the American Museum; a summary of the Coleoptera taken in the quarter of a square mile shows 1,093 species and 4,006 specimens.

The third division of this report deals with zoological work at Kartabo by the University of Pittsburgh. Under an agreement the university operated the station in British Guiana during the summer of 1925, opening it on June 8, and closing September 15. The matter for this report is furnished by Dr. S. H. Williams, who was in charge of the university class. The party, under his direction, consisted of twenty students representing ten American colleges and universities, and Howard E. Enders, professor of biology at Purdue University, as associate.

The policy of administration was one of conservation rather than exploitation. Many phases of life were studied and coincident ecological observations were carefully made. Specialized studies were as follows:

*Serpents*: Twenty-seven species were recorded, together with many notes on their habits, their arboreal, terrestrial and burrowing adaptations.

*Spiders*: A great variety of forms were collected and observations on their habits made. Attempts to study the virulence of the tarantulas were frustrated by total failure to induce the captives to bite.

*Geoplanidae*: A comprehensive survey of the Geoplanidae was carried on, but it is impossible yet to estimate the number of species secured.

*Mollusks*: Twenty-three species of land Gastropods were found and their habitats recorded. The aquatic forms are very scarce, not many species of either Gastropods or Pelecypods being found. The number of species and specimens was comparatively small, but the intensive study, in which every collecting device was used, was ecologically important.

*Trichoptera*: These were scarce in the months of June, July and August. Many larvae of *Heliopsyche* and *Hydropsyche* were taken along the river shores. Twelve species were taken. Efforts to raise adults in laboratory tanks and in mesh traps placed in the localities where larvae were found proved disappointing.

*Hemiptera*: Almost three hundred species of these, exclusive of the Membracidae, were collected.

*Coleoptera*: About six hundred species of beetles were taken, many of them being new to the previous collections.

*Diptera*: Two hundred species of dipterous insects (exclusive of the Tipulidae) were collected during the summer.

*Lepidoptera* (*Heterocera*): A rough estimate of the species collected places them at one hundred and fifty. No systematic collection of butterflies was made.

*Parasites*: Ectoparasites were collected extensively. All birds and animals, including monkeys, sloths and ant-eaters, were examined for Mallophage, Acarinids and ticks, and the entrails of all animals killed were examined for endoparasitic forms. Wasps were examined for Strepsiptera, and beetles for mites. In the last two cases the families and genera were, wherever possible, carefully recorded for comparison with our northern forms. Ticks, chigoes, bête-rouge and warble-flies were collected from rats, toads, monkeys —and the members of the party.

A systematic collection of Odonata was made for Dr. Hugo Kahl, of the Carnegie Museum.

In addition to the above a fresh-water porpoise was secured by great good fortune. It was the third specimen to reach the United States and will be reported in a special paper.

During the summer Professor H. D. Fish, head of the department of zoology of the University of Pittsburgh, visited the station to see what repairs and additional equipment would be necessary if the opportunity for further use should be offered.

The summer was a profitable one, and the possibilities for further studies in this spot are practically unlimited.

WILLIAM BEEBE

NEW YORK ZOOLOGICAL PARK

## THE BROOKLYN BOTANIC GARDEN

THE Fifteenth Annual Report of the Brooklyn Botanic Garden for 1925 has just been published. For the past fifteen years the people of Brooklyn, and in fact of all five Boroughs of Greater New York, have watched this institution grow from anticipations and blue prints to one of the leading scientific and educational institutions of the city.

In the matter of its educational work the Brooklyn Botanic Garden is a pioneer, and its educational program is now more extensive than that of any other botanic garden. Over 4,000 adults and children were registered in its various classes during 1925. The attendance of visiting classes from the public and pri-

vate schools was over 58,000, and the attendance at Botanic Garden classes was 30,000. The teaching of nature study and botany in our city schools was enriched by the supply of plant material to over 2,200 teachers in quantity sufficient for the instruction of over 162,000 pupils.

The Brooklyn garden is in correspondence with 110 foreign gardens and has sent over 3,200 packages of seeds from these institutions. In return the local garden has received seeds from these institutions. The plants raised from these seeds are annually enriching the plantations and have made the collections at the Brooklyn Garden one of the richest in number of varieties in the entire country.

The director calls special attention to the effective work which the Botanic Garden is doing for wild flower conservation, in cooperation with other organizations. This included securing the passage of legislation by the State Legislature so as to include various wild flowers in the conservation law, the growing and distribution of wild flowers now in danger of extinction, and the preservation of the wonderful weeping beech at Flushing, in Queens Borough. This is considered to be the largest and most beautiful specimen of this species of tree in the world. It would have been cut down to make way for an apartment house had not the Botanic Garden and other organizations supported the Park Commissioner of Queens in a campaign to save the tree.

The report includes an account of the important investigations in progress at the garden along the lines of plant breeding, plant diseases and the vegetation of Long Island. Of special popular interest is the progress being made in the study of the destructive chestnut tree disease. This disease started in New York City and so it is eminently fitting that studies looking toward its control or eradication should be made by a city institution. It has been estimated that the loss to this city alone, by the destruction of the chestnuts in parks and the watershed of the City water supply, amounted to not less than one million dollars.

Dr. Gager, the director of the garden, also calls attention to the disastrous effect on the trees of the garden and of all the city parks, especially the evergreen trees, by the soot and fumes produced by the burning of oil and soft coal during the past winter. The seriousness of this menace to all city trees can hardly be exaggerated.

Attention is also called to the increasingly large service which the garden is rendering to industrial and commercial concerns through its bureau of information. The information thus supplied by the Botanic Garden has resulted in the saving of thousands of dollars by these concerns.

The garden library contains the richest collection on Long Island of books on horticulture, gardening, and all aspects of plant life, including current numbers of about 800 periodicals on these subjects.

Since the Botanic Garden authorities assumed supervision of this part of the old East side lands the assessed valuation of the property, as noted by the director, has increased from $2,400,000 in 1913 to $7,000,000 last year. The value of all adjacent property has been correspondingly advanced by the development of the beautiful garden and its educational and scientific opportunities. Nearly one half the Botanic Garden budget for 1925 was obtained from private funds, much of which had to be secured by the uncertain method of solicitation of contributions.

Last May, after a thorough inspection of the Botanical Garden, its activities, equipment, finances and administration, Mr. John D. Rockefeller, Jr., offered personally to give $250,000 to the endowment fund provided the Garden authorities would secure an equivalent amount before the close of 1926. Mr. A. M. White is chairman of a special committee which has in charge the raising of this fund. This is a relatively small amount for these days, and especially considering the importance and extent of the Botanic Garden's work, and there should be no difficulty of going over the top with a wide margin.

## SCIENTIFIC EVENTS

### THE HARVARD EXPEDITION TO AFRICA

AN expedition to study diseases in Africa and to throw light on little-known forms of life left on May 15, headed by Dr. Richard P. Strong, director of the Institute of Tropical Biology and Medicine, Harvard University. The expedition is the first sent by the Harvard Medical School to Africa. Special attention will be given to the study of sleeping sickness and the effects of certain drugs on this disease. An entomologist, two zoologists, a bacteriologist, a clinician, a botanist and a photographer will make up the contingent of white men. Three hundred natives, to be picked up on arrival at Monrovia, will be taken along as porters.

Dr. Strong has made the following statement regarding the plans of the expedition according to an associated press dispatch:

> The African expedition, which is a continuation of the Amazon expedition of 1924–1925, will take a year and is certain to result in the discoveries of some new diseases, as we shall be penetrating country, studying men and plant and animal and insect life which have never yet been surveyed in this way.
>
> The expedition will sail for Great Britain, where it will be outfitted, a task requiring about a month. We have

to carry with us everything that we shall need for the entire year. This means not only all our scientific equipment—as we shall carry our laboratories along with us—but all our clothing and necessary comforts and safeguards. We should arrive at Monrovia, the capital of Liberia, on the west coast of Africa, about July 8. From there we shall proceed to Grajbassa, further down the coast, and then strike inland. We shall keep moving in a southeasterly direction, traversing a part of the Congo, and finally arriving at British East Africa, near Lake Alban and Mombasa.

Other members of the expedition, all on the staff of the Institute of Tropical Medicine, are: Dr. Joseph Bequaert, assistant professor of entomology, formerly with the Belgian sleeping sickness commission, with eight years' service in the Congo: Dr. Glover M. Allen, zoologist, author of special studies in East Africa on mammalian life; Dr. George Shattuck, assistant professor of tropical medicine, a participant in the Amazon expedition and, before that, on the typhus investigation in the Balkans; Dr. Max Theiler, bacteriologist, son of Sir Arnold Theiler, of South Africa, formerly of the London School of Tropical Medicine; Dr. Harold Coolidge, zoologist, formerly with the Smithsonian Institution; Mr. Loring Whitman, photographer, and a botanist not yet selected.

## A PRELIMINARY CONFERENCE ON UNIVERSITY RESEARCH

PLANS for a survey of research facilities in American universities in the field of pure science were made at a preliminary conference at the University of Pennsylvania on May 3 of representatives of universities, research institutions, foundations supporting research efforts, commercial laboratories and national scientific societies. The conference passed a resolution endorsing heartily the project of the National Academy of Sciences for the National Research Endowment. Secretary Hoover, Mr. Root and Mr. Hughes are leading the endowment campaign to raise $20,000,000 to aid American universities in carrying on fundamental research during the next ten years.

It was decided to call a general, formal conference next fall looking toward a comprehensive survey of university research work. This call is to be issued by a committee of seven representatives of universities and an advisory committee of seven representatives of various research organizations, to be appointed in the near future.

President Josiah H. Penniman, of the University of Pennsylvania, in his statement as presiding officer of the meeting, pointed out that, while all the agencies represented "have a common interest in research in pure science, the universities alone are directly responsible for the training of research workers." Research institutes and commercial laboratories have during the past few years drawn away from the universities many of the most experienced teachers and investigators "with the result that the teaching staffs of the universities have been weakened and the training of men for future research is seriously threatened."

Dr. Penniman then outlined a possible procedure "by which the university can better serve its function as a center of certain types of fundamental investigations and as the primary agency in the education and training of investigators."

Those present at the Philadelphia conference were:

Dr. J. C. Merriam, Carnegie Institution of Washington, D. C.; Dr. William C. White, United States Public Health Service; Dr. Alfred H. Lloyd, University of Michigan; Dr. Arthur H. Daniels, University of Illinois; Dr. Henry H. Donaldson, the Wistar Institute, Philadelphia; Alfred D. Flinn, Engineering Foundation; General John J. Carty, American Telephone and Telegraph Company; Dr. Howard McClenahan, secretary, the Franklin Institute, Philadelphia; Dr. William C. L. Eglin, president, the Franklin Institute, Philadelphia; Dr. Vernon Kellogg, National Research Council; Dr. H. F. Blichfeldt, Stanford University; Professor L. R. Jones, University of Wisconsin; W. R. Whitney, Research Laboratory, General Electric Company; Chancellor Elmer Ellsworth Brown, New York University; Professor Michael Pupin, Columbia University; Dr. Charles H. Warren, Yale University; Professor L. J. Henderson, Harvard University; Dr. Simon Flexner, Rockefeller Institute; Dr. Livingston Farrand, president, Cornell University; Professor J. S. Ames, Johns Hopkins University; Dr. Josiah H. Penniman, provost, University of Pennsylvania; Professor A. O. Leuschner, University of California.

## AWARDS OF THE LAPHAM MEDALS OF THE WISCONSIN ARCHEOLOGICAL SOCIETY

TEN men were awarded the Lapham medal given for distinguished research work in anthropology at the recent silver anniversary meeting of the Wisconsin Archeological Society. They are: Charles E. Brown, director of the State Historical Museum, Madison; George A. West, Milwaukee; Dr. S. A. Barrett, Milwaukee; Dr. George L. Collie, Beloit; H. E. Cole, Baraboo; John P. Schumacher, Green Bay; Dr. Alfonso Gerend, Milladore; H. L. Scavlam, Janesville; Dr. W. G. McLaughlin, McFarland, and George R. Fox, Three Oaks, Mich.

When the society organized in 1901 the members decided to award a medal annually to those members who performed notable research work in anthropology in Wisconsin. This is the first year, however, that the award has been made. Most of the men who received the medal were members of the society for almost 25 years. All conducted research at their own expense.

As a result of the work done by the men enough material for 25 volumes of Wisconsin anthropology has been collected.

The medal is about one and one half inches in diameter, made of Lake Superior copper, and designed by Raymond L. Maas, a Milwaukee artist. It is called the Lapham medal after Increase A. Lapham, who came to Milwaukee and began his research in 1836, and died there in 1875. On the obverse side of the medal is a profile of Dr. Lapham encircled by a string of wampum. On the reverse side a thunder bird symbol signifying the Indian deities of the upper world is found at the top. At the bottom is the Indian symbol of the underground panther or water spirit signifying the lower world. Another string of wampum encircles these designs. Although the Wisconsin Archeological Society was one of the first to be founded, there now exist similar societies in Iowa, Indiana, Michigan, Missouri and Tennessee.

## NATIONAL RESEARCH FELLOWS IN THE MEDICAL SCIENCES

FOLLOWING is a list of the fellows in medicine recently appointed by the Medical Fellowship Board of the National Research Council:

Harold A. Abramson, M.D., Libman fellow at the University of London; physiology or medicine, to work with A. V. Hill, London.

Martin H. Dawson, M.D., of the Royal Memorial Hospital, Montreal; medicine; R. Cole, Rockefeller Institute, or F. W. Peabody, Harvard.

Arthur R. Elvidge, M.D., Cooper research scholar at McGill University; physiology; J. Erlanger, Washington University, C. J. Wiggins, Western Reserve, or A. J. Carlson, Chicago.

Peter Heinbecker, M.D., house surgeon, Presbyterian Hospital, New York; physiology or surgery; R. Gesell, California, or J. Erlanger, Washington University.

Francis F. Heyroth, M.D., Seeley fellow at the University of Cincinnati; biochemistry; E. J. Cohn, Harvard.

Charles G. Johnston, M.D., student assistant at Washington University; biochemistry; H. B. Lewis, Michigan, or D. W. Wilson, Pennsylvania.

Florence M. McDonald, M.B., assistant in pathology at Johns Hopkins University; neuropathology or neuroanatomy; G. C. Huber, Michigan, or C. J. Herrick, Chicago.

Jacob Markowitz, M.B., Ph.D., demonstrator in physiology at Toronto; physiology; E. K. Marshall, Jr., Johns Hopkins, or J. Erlanger and H. S. Gasser, Washington University.

Walter S. McClellan, M.D., resident physician at Bellevue Hospital; physiology; G. Lusk, Cornell Medical.

Hobart A. Reimann, M.D., assistant resident physician at Rockefeller Institute; pathology; Anton Ghon, Prague.

Howard J. Shaughnessy, Ph.D., instructor in public health at Yale University; bacteriology; E. O. Jordan, Chicago.

Ralph G. Smith, M.B., interne at Toronto General Hospital; pharmacology; T. Sollmann, Western Reserve, or H. S. Gasser, Washington University.

Wm. L. Straus, Ph.D., student at Johns Hopkins; anatomy; place of work not determined.

Maurice L. Tainter, M.D., instructor in pharmacology at Stanford; pharmacology; place of work not determined.

Willard O. Thompson, M.D., research fellow in medicine at Harvard; biochemistry; L. J. Henderson, Harvard.

Thomas E. Wood, M.D., instructor in medicine at the University of Virginia; physiology; Sir Thos. Lewis, London.

Following is a list of those reappointed:

Leopold R. Cerecedo, Ph.D.; biochemistry; L. B. Mendel, Yale.

Rudolph Fisher, M.D.; bacteriology; F. P. Gay, Columbia.

Wm. P. Gillespie, M.D.; (obstetrics) physics or physiology; L. More and M. H. Fischer, Cincinnati.

Francis D. Gunn, M.D.; pathology; B. Roman and H. U. Williams, Buffalo.

Franklin Hollander, Ph.D.; biochemistry; L. B. Wendell, Yale.

Homer D. Kesten, M.D.; pathology; J. W. Jobling, Columbia.

Geo. M. Lawson, M.D.; bacteriology; H. Zinsser, Harvard.

Robert O. Loebel, M.D.; physiology; G. Lusk, Cornell Medical.

Clive M. McCay, Ph.D.; biochemistry; L. B. Mendel, Yale.

Howard A. McCordock, M.D.; pathology; W. G. MacCallum, Johns Hopkins.

I. Theodore Rosen, M.D.; physiology; J. Erlanger, Washington University.

Noel F. Shambaugh, M.D.; biochemistry; place of work not determined.

Barbara B. Stimson, M.D.; (surgery) physiology, from C. J. Wiggers, Western Reserve, to H. B. Williams, Columbia.

Maurice B. Visscher, Ph.D.; physiology; A. V. Hill, London.

Herbert S. Wells, M.D.; biochemistry; place of work not determined.

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## SCIENTIFIC NOTES AND NEWS

DR. HENRY FAIRFIELD OSBORN, president of the American Museum of Natural History, has been elected a foreign member of the Royal Society of London.

THE Willard Gibbs Medal of the Chicago section of the American Chemical Society has been awarded this year to Sir James Colquhoun Irvine, of the University of St. Andrews, Scotland. The presentation will take place at the September meeting of the Chicago section when Dr. Irvine will be in this country to attend the Philadelphia meeting of the American Chemical Society.

DR. JOHN M. COULTER has been elected corresponding member of the Zoologisch-Botanische Gesellschaft of Vienna.

DR. M. I. PUPIN, professor of electromechanics at Columbia University, has been elected a trustee of Science Service, upon nomination of the American Association for the Advancement of Science.

PROFESSOR CHARLES R. RICHARDS, director of the American Association of Museums, has received the decoration of the Legion of Honor from the French government.

DR. RICHARD POHLE, professor of geology in the Institute of Technology at Braunschweig, has been elected a corresponding member of the Geographical Society of Helsingfors, Finland.

DR. KARL SUDHOFF, professor of the history of medicine at the University of Leipzig, has been made an honorary member of the Royal Society of Medicine, London.

PROFESSOR V. A. STEKLOV, director of the Institute of Mathematics and Physics at Leningrad, has been elected a corresponding member of the Göttingen Academy of Sciences in the section of mathematics and natural sciences.

MAJOR J. HALL-EDWARDS, a pioneer worker in X-ray therapy, has been elected an honorary member by the council of the British Medical Association in recognition of his services to medicine.

DR. WILLIAM G. EXTON, Newark, N. J., was elected president of the American Society of Clinical Pathologists at the annual meeting which took place from April 15 to 17 in Dallas, Texas; Dr. Arthur H. Sanford, Rochester, Minn., *president-elect;* Dr. James H. Black, Dallas, Texas, *vice-president,* and Dr. Ward T. Burdick, Denver, *secretary-treasurer.*

R. E. HALL, formerly physical chemist at the Pittsburgh Experiment Station of the U. S. Bureau of Mines, has resigned to become director of the Hall Laboratories, Inc., Pittsburgh.

DR. JOHN A. MANDEL, professor of biological chemistry in New York University, was the guest of honor at the eighty-seventh annual dinner of the Alumni Association of New York University and Bellevue Hospital Medical College on May 8 at which approximately four hundred graduates were present.

DR. LORRAIN SHERMAN HULBURT, professor of mathematics at the Johns Hopkins University, will retire at the end of the present academic year.

DR. ALEŠ HRDLIČKA, curator of the division of anthropology of the U. S. National Museum, left on May 17 for Alaska to make a scientific survey of the probable route by which primitive man first reached the American continent. The expedition is under the auspices of the U. S. Bureau of Ethnology.

TO preserve the homes of the prehistoric Indians of the Grand Canyon area, Dr. J. Walter Fewkes, chief of the U. S. Bureau of Ethnology, has left Washington for a summer's work in Arizona. He will concentrate his attention at the Wupatki national monument near Flagstaff.

NEIL M. JUDD, curator of American archeology, expects to leave Washington about May 15 to resume direction of the National Geographic Society's exploration of Pueblo Bonito, a prehistoric ruin in northwestern New Mexico.

F. G. COTTRELL, director of the Fixed Nitrogen Research Laboratory, Washington, D. C., has sailed for Biarritz, where he represented the United States at the joint conference of the British Sulfate of Ammonia Federation and the German Nitrogen Syndicate held on April 28 and 29. Russell A. Oakley, of the U. S. Department of Agriculture, is a second American representative.

LIONEL S. MARKS, professor of mechanical engineering at Harvard University, is on leave of absence for the second half of the current academic year. He is spending his time investigating developments in engineering practice in Germany, France and England.

SIR SPENCER LISTER, research bacteriologist for the South African Institute of Medical Research, Johannesburg, arrived in New York on April 17.

DR. WALTER LEHMANN, director of the Research Institute Museum of Berlin, Germany, is visiting the United States.

IT is reported from Paris that Professor A. Pettit, of the Pasteur Institute, has been deputed by the French government to organize a similar Pasteur Institute at Montreal at the request of the University of Montreal, of which it will be a department.

THE ninth series of the Harrington lectures was given at the school of medicine of the University of Buffalo, on May 6 and 7, by Dr. Charles R. Stockard, of Cornell University Medical College. The first lecture was on "The Mechanism of Inheritance" and the second on "Inheritance and Development."

DR. H. G. WELLS, professor of pathology at the University of Chicago, delivered an address on "Heredity and Cancer," before the faculty and students at the University of Colorado Medical School, on May 10. On the same day a dinner was given in honor of Dr. Wells at the National Jewish Tuberculosis Hospital, by Dr. H. J. Korper, at which Dr. Henry Sewall presided.

DR. HARRY N. HOLMES, professor of chemistry at Oberlin College, gave on April 24 a lecture in French at the University of Paris on his work in colloid chemistry.

WE learn from *Nature* that a memorial lectureship and medal have been founded at the University of Glasgow in commemoration of the late Professor Sir William Macewen, F.R.S. The lectureship will be biennial, and the memorial lecture will deal with advances in surgery. The memorial medal will be awarded annually to the most distinguished candidate in the final or qualifying examinations in surgery of the year.

A COMMISSION appointed by the Medical Society of Virginia met in Richmond late in April and authorized the purchase of the little frame building at Belroi, in which Walter Reed was born, as a memorial to the discoverer of the means of transmission of yellow fever.

DR. CARL HERING, consulting engineer of Philadelphia, past president of the American Institute of Electrical Engineers and of the American Electrochemical Society, died on May 11, aged sixty-six years.

SIR HARRY BROOKES ALLEN, professor of pathology and dean of the faculty of medicine at Melbourne University, Australia, has died, aged seventy-one years.

THE United States Civil Service Commission announces open competitive examinations for associate chemist, at a salary of $3,000, and assistant chemist, at a salary of $2,400. Receipt of applications for these positions will close June 22. The examinations are to fill vacancies in the departmental service, Washington, D. C., and in positions requiring similar qualifications.

REPORTS of progress in engineering research were presented at the May dinner of the Engineering Foundation at the Union League Club on May 19. Edward Dean Adams, who won the John Fritz gold medal for meritorious achievement in science and industry, was the guest of honor. For ten years Mr. Adams has been vice-chairman of the foundation board. Lewis B. Stillwell, chairman of the foundation, presided. Speakers included Dr. John A. Mathews, vice-president of the Crucible Steel Company of America, and Professor Richard S. McCaffery, of the University of Wisconsin.

THE National Association of Inventors, having chapters and memberships in Washington, Oregon, California, British Columbia and other states, will hold its second annual convention in Portland, Oregon, on June 17, 18 and 19, and in connection with the convention will stage an exposition of inventions.

THE fourth soirée for 1926 of the Iowa Chapter of Sigma Xi was presented on May 5 with the zoology department of the State University of Iowa in charge. The program included five scientific papers and a number of exhibits of research material.

BECAUSE of the fact that sufficient funds have not been raised, which would be necessary to launch the University of Michigan Expedition to Greenland this summer, and it is now too late to make arrangements for the project, Professor William H. Hobbs, of the geology department, has announced that the expedition as regards its main purpose has been postponed until the summer of 1927. However, Dr. Hobbs proposes to make a preliminary trip to the Arctic region this summer, with a small university party in preparation for the main expedition a year later. The sum estimated as necessary for the expedition is $100,000. The total now subscribed is only about $9,000.

THE Field Museum of Natural History of Chicago will send an expedition into South America this summer to collect specimens of mineral, animal and plant life, which will sail on June 19 on the *Pan-American* for Rio de Janeiro. It will be financed by Captain Marshall Field and will include in its personnel George K. Cherrie, who accompanied the Roosevelt expedition into Central Asia last year. Mrs. Marshall Field and Mrs. Grace Thompson Seton will be the official photographers of the party of nine.

THE U. S. Senate has passed the bill providing for the acquisition of the Mount Hamilton tract, near the upper Anacostia River, for the establishment of a national arboretum for the Department of Agriculture. The amount authorized to be appropriated was reduced by the senate from $500,000, as recommended by the committee on agriculture, to $300,000 after several senators had expressed the belief that the lesser amount would be sufficient. The bill now goes to the house for action. The senate also adopted amendments proposed by Senator Jones, of Washington, which would make the arboretum available also for recreational and park purposes.

A BILL to prohibit the teaching of evolution theories in universities, normal and other public schools and state institutions supported in whole or part by public school funds was introduced in the Louisiana Legislature on May 11.

DR. D. C. BALFOUR, a graduate of the University of Toronto, now with the Mayo Clinic, has offered to the University of Toronto $4,000 for the establishment of a lectureship in surgery and the board of governors has gratefully accepted his offer. This foundation will probably be used to bring notable surgeons from time to time to the university to deliver special lectures.

*Industrial and Engineering Chemistry* states that a commercial exhibit illustrating the developments in American chemical industry by representative chemical concerns will be one of the features of the fiftieth anniversary of the American Chemical Society to be celebrated in Philadelphia next September. The proposed exhibit was approved by the American Chemical Society at its recent meeting in Tulsa. Major Harry S. Kimberly was chosen to organize and supervise the undertaking. There will be an exhibit of representative commercial concerns showing the progress of various branches of chemical industry in the last fifty years. This exhibit will be held in the gymnasium of the University of Pennsylvania, which is one of the group of buildings in which the society will hold its meetings.

THE *Journal* of the American Medical Association states that the U. S. Department of Agriculture will undertake a survey in July to determine the kinds of food eaten throughout the United States, the quality and the quantities consumed in various sections. There are said to have been no adequate figures on food consumption available, and there is a demand for such information for scientific research and various other groups. It is planned to determine also whether an adequately nutritive diet is within the incomes of large groups of people. A committee will be appointed to conduct the survey.

THE United States Department of the Interior has recently issued a permit to the National Geographic Society which will allow the society to conduct additional archeological excavations in the Chaco Canyon National Monument, New Mexico, during 1926. The new permit authorizes the collection of material from the heaps of débris at the two ruins known as Pueblo Alto and Penasco Blanco. The work of the National Geographic Society during the past five years at Pueblo Bonito del Arroyo in excavating has been so interesting that the Interior Department authorized the continuance of this work during 1926, and the new investigations at Pueblo Alto and Penasco Blanco will supplement this main excavation project.

JOINT investigations by the Bureau of Soils of the United States Department of Agriculture and the United States Geological Survey to determine the location and extent of potash deposits in the United States and to develop improved methods of recovering potash therefrom are provided for in a bill (S. 1821) which has been reported out with amendments by the Senate Committee on Agriculture. It would appropriate $550,000 for the fiscal year ending June 30, 1926, and a similar amount for each succeeding fiscal year for four years.

AT a meeting of the executive committee of the Tennessee Academy of Science on March 30 the following resolution was adopted: "Inasmuch as the Tennessee Academy of Science at the annual meeting, November 27, 1925, passed a resolution recommending the repeal of what is known as the Anti-Evolution Act (House Bill 185, approved by the Governor March 21, 1925) and the case of the State *vs.* Scopes, which is now before the Supreme Court of Tennessee, involves the constitutionality and validity of this law, it seems fitting that the academy should have the privilege through counsel of filing a brief and participating in the argument before the court. Therefore the executive committee acting for the Tennessee Academy of Science hereby authorizes its president, A. F. Ganier, to engage competent counsel on as favorable terms as he may be able to secure to represent the academy in this case before the Supreme Court of Tennessee.

NALINI RAJAN CHOUDHURY has donated a medal, to be known as the Mahamaya gold medal, to be awarded under the auspices of Calcutta Mathematical Society, for an essay on the Hindu-Arabic numerals. Competition is restricted to graduates of or students in an Indian university.

THE Zeta Chapter of Sigma Delta Epsilon, graduate women's scientific sorority, has recently been organized at Brown University.

THE *American Journal of Surgery*, of which Dr. Walter M. Brickner has been editor for twenty-one years, has been purchased by Paul B. Hoeber, Inc., medical publishers. It is planned to increase the size of the journal and Drs. Harvey Cushing, Joseph A. Blake, Rudolph Matas, Fielding H. Garrison and others will join the advisory editorial staff, in association with Dr. Brickner.

IT is reported from Leningrad that a translation of Professor Pavlov's book on "Conditioned Reflexes" will soon be published in the English language. The translation is being made by Dr. W. H. Gantt, an American who for the past eighteen months has been working in Pavlov's laboratory.

PROFESSOR J. SPEK, of the University of Heidelberg (Germany), and Professor F. Weber, of the University of Graz (Austria), have, with the cooperation of Professor R. Chambers (New York) and Professor W. Seifriz (Philadelphia) founded a new periodical which is to be devoted to the publication of research on the physical chemistry of protoplasm. Manuscripts will be accepted for publication in German, English, French or Italian. The publishers are Gebrüder Borntraeger, Berlin. The first number is expected to appear in June of the present year. Over one hundred investigators have so far expressed their willingness to support the new journal. All communications should be directed to Professor F. Weber, Schubertstrasse 53, Graz, Austria.

FOLLOWING the International Congress on Scientific Organization held in Brussels last September, a movement has been started in that city to organize a Belgian National Committee of Scientific Organization.

## UNIVERSITY AND EDUCATIONAL NOTES

THE University of Rochester announces that the formal opening of its school of medicine and dentistry will be on October 25 and 26. There will be scientific medical conferences on these two days. Papers will be presented by Professor Friedrich Müller, of Munich; Dr. C. J. Martin, president of the Lister Institute of London, and by other leaders in medical science. The formal invitations will be sent out some time in September and the program will probably be complete before that date.

A GIFT of $50,000 from the estate of the late John D. Larkin, of Buffalo, N. Y., made through his son, John D. Larkin, Jr., has been announced by Lafayette College, which is to be added to a fund of $200,000 given in 1924 by Mr. Larkin for the maintenance of the department of chemistry.

DR. JOSEPH A. CUSHMAN, director of the Cushman Laboratory for Foraminiferal Research, has been appointed lecturer on micropaleontology at Harvard University. The laboratory at Sharon, Massachusetts, will be available to graduate students in the department of geology who desire to do research under Dr. Cushman's direction. This laboratory is especially designed and equipped for the investigation of foraminifera and other fossil remains of minute dimensions.

DR. GEORGE H. SMITH, of the department of bacteriology, and Dr. George E. Nichols, of the department of botany, have been promoted to full professorships at Yale University. Joshua I. I. Tracey and James H. Whittemore have been promoted to associate professorships in the department of mathematics.

AT Clark University, Dr. Charles F. Brooks has been promoted to professor of meteorology and climatology and Dr. Clarence C. Jones to associate professor of economic geography.

DR. J. EDWIN SWEET, of the University of Pennsylvania, has been appointed professor of surgical research at Cornell University Medical College and Dr. Walter C. Klotz director of the Cornell clinic and assistant professor of hygiene.

PROFESSOR W. W. SWINGLE, of Yale University, has been appointed professor of zoology and director of the museum at the University of Iowa. He succeeds Professor C. C. Nutting, who is retiring after forty years' service to devote his full time to research work.

AT the University of Pennsylvania, Dr. Eliot R. Clark, of the University of Georgia School of Medicine, has been appointed professor of anatomy; Dr. David H. Bergey has been promoted to professor of hygiene and bacteriology; Horace B. Baker to be assistant professor of zoology; Dr. Morton McCutcheon to be assistant professor of pathology; James C. Andrews to be assistant professor of physiological chemistry, and Dr. Stanley O. Chambers to be assistant professor of dermatology and syphilology.

DR. HARRY V. ATKINSON, professor of pharmacology at the University of Texas School of Medicine, has been appointed associate professor of pharmacology at Iowa State University College of Medicine. W. T. Dawson, now associate professor of physiology at Texas, has been appointed associate professor of pharmacology.

## DISCUSSION AND CORRESPONDENCE

### THE CONTRACTILE VACUOLE GRANULES IN AMOEBA PROTEUS

DR. MAST, in his fine paper upon "Structure, Movement, Locomotion and Stimulation in Amoeba,"[1] judges "that my observations upon the localization of the contractile vacuole function[2] were made upon inactive specimens (*i.e.*, specimens not in locomotion). It may be worth recording that the constant association of the contractile vacuole with a certain group of granules, the now vacuole appearing among the old granules, obtains in both mobile and immobile specimens, and that the phenomena were followed in all cases under high powers of the microscope, continuously for hours. I have no opinion as to the function of the contractile vacuole in Amoeba, though I followed the prevalent custom in calling the vacuole excretory and so called the granules excretory.

In *Protoopalina* there are similar (?) granules surrounding the posterior vacuole of the "excretory" system of tubules, and these granules stain differently from the cytoplasmic granules. In *Protoopalina* some of these "excretory" granules drop into the lumen of the posterior vacuole and are thrown out to the exterior when, at irregular intervals, it contracts.

In both *Amoeba* and *Protoopalina* granules resembling in size and appearance the cytoplasmic granules gather around the contractile vacuole. In *Amoeba* differential staining or extrusion of these granules has not been observed; in *Protoopalina* both differential staining and extrusion are readily seen, though prolonged observation may be necessary to catch the actual extrusion. The differential staining

[1] *Journal of Morphology*, v. 41, No. 2, March 5.
[2] *Journ. Exper. Zool.*, vol. 9, pp. 301–331.

(dull, dirty blue, contrasted with the clearer blue of the cytoplasmic granules) with Delafield's haematoxylin in *Protoopalina,* is no sufficient indication of renal function of the vacuole system and its granules. These granules may, of course, be merely degenerate and not at all specialized for renal function. Experimentation with chemical indicators and the micropipette upon the contractile vacuole contents in *Amoeba,* some large ciliate, like *Paramecium,* and upon *Protoopalina* (with its peculiarly behaving granules) should be of interest.

MAYNARD M. METCALF
JOHNS HOPKINS UNIVERSITY

## DIGESTION OF WOOD BY THE SHIPWORM

WHETHER the marine wood-boring mollusks of the family Teredinidae, commonly known as shipworms, bore in submerged timber for protection only, or also for the purpose of utilizing the wood as food, has been a subject of considerable debate. It has been shown by Dore and Miller[1] that about 80 per cent. of the cellulose, and from 15 to 56 per cent. of the hemicelluloses, in Douglas fir piling disappear from the wood during its passage through the digestive tract of *Teredo navalis.* The conclusion was drawn that the carbohydrates which disappear are utilized by the organism as food. This conclusion has lately been substantiated by a different method, in the case of another species of a related genus.

A number of specimens of the Northwest shipworm (*Bankia setacea* Tryon), from one to two feet in length, were removed from samples of Douglas fir timber submerged about one year at the Puget Sound Biological Station. On dissection, a sufficient quantity of wood-borings was obtained from the caeca of these organisms to test for reducing sugars. A similar test was made on a pulverized sample of the original wood. The reducing sugars were determined as glucose by the Benedict-Osterberg method, as modified by Thomas and Dutcher.[2] The following results were obtained:

| | |
|---|---|
| Reducing sugars (as glucose) in original wood | 0.92 per cent. |
| Reducing sugars (as glucose) in wood from caecum | 3.86 per cent. |

The amount of reducing sugars in the wood from the caecum is thus about four times as great as the amount found in the original wood. The data are not of quantitative significance in indicating the total amount of sugar formed, as the wood in the caecum is presumably still in process of digestion, while on the other hand a certain amount of sugar has doubtless already been lost by absorption through the walls and typhlosole of the caecum. The results do, however, indicate a decided increase in the quantity of reducing sugars while the wood is in the digestive tract, which is the logical reciprocal of the disappearance of the more stable carbohydrates that was noted in the case of wood-borings which had passed through the digestive tract of *Teredo navalis.*

Thus there is evidence of the digestion of wood in a representative species of each of the two principal genera of shipworms, and it is probably a justifiable assumption that carbohydrates from the wood play an important rôle in the nutrition of this interesting group of lamellibranchs.

ROBERT C. MILLER
LYMAN C. BOYNTON
UNIVERSITY OF WASHINGTON

[1] Univ. Calif. Publ. Zool., *22,* 383–400. 1923.
[2] *Jour. Amer. Chem. Soc., 46,* 1662–69. 1924.

## WOODPECKERS AND THE AUTOMOBILE

I HAVE read with interest the letter of Henry L. Baldwin in regard to woodpeckers and the automobile (SCIENCE, April 2, 1926, p. 358), and am inclined to agree with much that he says. I have reason, however, to object to the following statement, contained in the letter: "The red-headed woodpecker is practically non-existent in this region, having been seen in northern New York only once by the writer, and that many years ago." I do not question the validity of his observations: but his apparent reliance upon his own notes as the sole source of information is open to criticism. In this region, which is certainly a part of northern New York, a number of records of the red-headed woodpecker have been obtained during the past four years: cursory examination of my notes shows records for this species on April 7 and 21, 1923, and on March 8, 1925. These records were all taken within ten miles of this place. Although they can not be taken as an indication of distribution outside of this limited area or of particular abundance, they certainly show that the species is somewhat far from non-existent.

FREEMAN F. BURR
ST. LAWRENCE UNIVERSITY

## ANNUAL EXHIBITION OF THE ROYAL PHOTOGRAPHY SOCIETY

THE Royal Photographic Society of Great Britain are holding their seventy-first annual exhibition in September and October of this year. This is the most representative exhibition of photographic work in the world, and the section sent by American scientific men heretofore has sufficiently demonstrated the place held by this country in applied photography. It is very desirable that American scientific photography should

be equally well represented in 1926, and, in order to enable this to be done with as little difficulty as possible, I have arranged again to collect and forward American work intended for the scientific section.

This work should consist of prints showing the use of photography for scientific purposes and its application to spectroscopy, astronomy, radiography, biology, etc. Photographs should reach me not later than Saturday, June 12th. They should be mounted but not framed. There are no fees.

I should be glad if any worker who is able to send photographs will communicate with me as soon as possible so that I may arrange for the receiving and entry of the exhibit.

A. J. NEWTON

EASTMAN KODAK COMPANY,
ROCHESTER, N. Y.

## REQUEST FOR DATA ON THE TWILIGHT SONG OF THE WOOD PEWEE

THE wood pewee, one of the commonest birds of the eastern United States and Canada, sings a long, complex musical composition known as the twilight song. It is named "twilight song" because it is sung regularly at dawn, rarely at sunset, and never at any other time of day. The song lasts continuously for a very long time, even as long as forty minutes; but it contains only three different phrases, which I shall speak of as phrases 1, 2 and 3, and which are readily distinguishable from each other, thus affording a basis of exact analysis. A brief, preliminary description of the song can be found in the current (April) number of *The Auk*. Although there are only three different phrases, their order of succession is remarkably complex, and individual variations are so great that apparently each individual wood pewee sings a composition of his own. A thorough study of these compositions will be sure to yield results of great interest. I request that scientists and also non-scientific persons (if only they are accurate) will make records of the song for me. To make the record, you simply write the number of each phrase, 1, 2 or 3, as the case may be, while the bird is singing. This can be done by any person who is careful and reliable and has a sufficiently good ear to follow a tune. The only difficulty is that you need to rise and go out before daylight on one of the long days of early summer, in order to get a complete record. Few persons have the time to spare and the necessary interest and enthusiasm to do this. If you can take the time to make one complete record, it will be a valuable contribution. Please write to the undersigned for a copy of the directions for making a record.

WALLACE CRAIG

HARVARD MEDICAL SCHOOL,
BOSTON, MASS.

## SCIENTIFIC BOOKS

*Manual of Injurious Insects.* By GLENN W. HERRICK. New York, Henry Holt & Co., 1925, 474 pp., 458 illustrations.

ONE of the reasons why entomologists until comparatively recent years were so numerous in Europe and so scarce in America was the lack of books over here which would enable collectors to identify species. The lack of this kind of books still exists, although to a much lesser degree, in the United States. But during the past dozen years a number of good books have been published in this country on the subject of applied entomology, and of these books Professor Herrick's volume is the latest and in many respects the best. It is worthy of note that most of these books have been written by teachers, and their aim has been not only to tell everybody about injurious insects and how to combat them but to place before students a compendium of economic entomology in this country down to the date of writing. I have never taught applied entomology, but it seems to me that, if I were to try to teach, this book would be the one I should use before any as yet published.

Herrick's volume must be praised very highly. It has many good points. The illustrations are competent, and the majority of them are new. And the author has introduced several new features which are excellent. For example, wherever possible he has introduced with the consideration of each one of the principal crop pests a small outline map of the United States indicating the geographic distribution of the insect. It has not been possible to do this in all cases, on account of lack of records, but where it has been possible it can not fail to be of very great use. It shows at a glance conditions which it would take many lines of print to describe.

Another point which makes the book very useful is the introduction of synopses of the chief insects affecting the different crops. For example, after the consideration of insects injurious to apple, there is a synopsis of the chief insects injurious to this fruit in the United States, arranged according to the character of their work as well as to their general appearance in all stages; and this is done in popular language so that the apple grower will be able to find out immediately just what insect is damaging his trees, and he can do it without sending specimens to some distant economic entomologist.

Then too, Herrick has been careful to indicate in his legends to the illustrations the actual size of the insect, an important point neglected by some recent popular writers on insects, thus causing serious misconceptions. His proofreaders, unfortunately, overlooked this in a few instances, as in the case of the

woolly root-louse (Figure 59) and that of the Japanese beetle grub (Figure 62).

It is an interesting thing to see how different people go at practically the same thing in different ways. When Dr. H. T. Fernald five years ago wrote his "Applied Entomology, an Introductory Textbook of Insects in their Relation to Man," he filled an interesting volume of nearly four hundred pages with economic facts about insects and he arranged his material according to the zoological grouping of the insects. This was also the method used by Herbert Osborn in his admirable "Agricultural Entomology" published in 1916. In 1921 a somewhat larger work by Sanderson and Peairs was published, but here the material was arranged according to the crops affected by the injurious insects or by the classification of the other damage that they do. This method reflects the organization of the federal Bureau of Entomology, which has divided its work largely on ecological lines.

In the present book Professor Herrick has in the main adopted the method of treatment used by the latter authors. The title of the Sanderson and Peairs book is "Insect Pests of Farm, Garden and Orchard," whereas that of Herrick is "Manual of Injurious Insects." The latter title, while short and to the point, is a bit misleading, since the title itself has no geographical limitation and the insects treated are solely those of the United States. Moreover, in the book there is no consideration of the insects that damage forests and shade trees (with the exception of a short appendix on the gipsy and brown-tail moths), and one looking, possibly with some confidence, in the books for shade-tree pests or forest pests will be disappointed.

It is interesting to note that nearly a third of the volume is devoted to the consideration of insects injurious to fruits, large and small, whereas the space devoted to insects affecting cereal and forage crops covers less than half that, and the space devoted to insects affecting vegetables is also about half as great as that devoted to fruits. This does not necessarily mean that Professor Herrick considers the fruit industry more important than the real food crops of man and animals, but, as it happens, there seem to be more different kinds of insects that attack fruits.

The book is dedicated to the memory of Ezra Cornell, and in the dedication a sentence is quoted from Cornell's address at the founding of Cornell University in which he brought out strikingly the necessity for the study of economic entomology. The dedicatory words would lead one to think that work in this direction must have been started immediately after the university opened its doors, but as a matter of fact it was not started until about six years later, when J. H. Comstock appeared on the scene. The reading of this dedicatory note has given me a surprise. I knew Ezra Cornell when I was a boy in Ithaca. I had the honor of being driven out of his orchard once by the old gentleman himself. His tall hat and his heavy cane were enough to frighten any small boy. He never told me on this and other occasions that he was interested in economic entomology, but now I know that perhaps he was indirectly responsible for my own method of getting a livelihood.

Professor Herrick succeeded Professor Comstock in a part of his important work in building up a great department of entomology at Cornell, and in this book he has shown his sure competence.

L. O. HOWARD

BUREAU OF ENTOMOLOGY,
WASHINGTON, D. C.

## SCIENTIFIC APPARATUS AND LABORATORY METHODS

### A METHOD OF DEMONSTRATING THE EMBRYONIC MEMBRANES OF THE CHICK

IT is of considerable advantage to the teacher of embryology to be able to show the relations of developing fetal membranes by demonstration of the actual material rather than by use of the customary diagrams alone. The method described here gives excellent results for the membranes of the incubating chick and depends upon the absorption of a one per cent. solution of trypan blue (vital stain) by the allantois. A similar technique is being used in this laboratory for the study of fetal absorption.

The incubating egg (White Leghorn) is candled and the position of the allantoic cavity, which shows as a comparatively clear area surrounding the shadow of the chick, noted. The allantoic position may be detected as early as the beginning of the fifth day, although at this early stage the allantois does not completely cover the embryo. A small hole is made through the shell into the allantoic cavity by means of a sharp dissecting needle. A slightly larger hole is made through the shell at the top of the air sac to relieve the pressure caused by injection into the allantoic cavity.

The dye is made up fresh in distilled water and does not need to be warmed to body temperature. It is injected with a hypodermic syringe equipped with a twenty-seven gauge needle. The amount injected depends upon the stage of development and may easily be determined by holding the egg before the candle during the process of injection. During the fifth and sixth days of incubation a few drops of dye are sufficient. In the later stages not more than one half cc is required. The needle holes are sealed each with a drop of wax (Clark's method)[1] and returned to the

[1] Clark, Eliot R., SCIENCE, 1920, li, 1319.

incubator, operated side down, to be further incubated for six to twelve hours.

For demonstrating the membranes, the shell is broken at the air sac and the entire egg immersed in a suitable dish of cold water. Enough of the shell is then removed to allow the contents to gravitate free into the dish. With a reasonable amount of care this may be accomplished without injury to either the yolk or allantoic membranes. Small tears in the stained allantois will not damage the preparation and dye escaping from the allantoic cavity may be washed away.

After the intact egg membranes have been viewed by the students the allantois is grasped about a quarter of an inch from its edge by means of smooth forceps and slightly tensed to bring into view the chorionic membrane as it stretches across from the allantoic sac to the yolk sac. With small scissors the chorion is cut along the edge of the allantoic sac without injury to other membranes. This allows the allantois to float free, except for attachments at its stalk and seroamniotic connection, both of which are plainly seen. The freeing of the allantoic sac brings to view the vitally stained[2] embryo surrounded by the amniotic sac resting on the yolk sac. The amniotic fluid is clear. While the embryo is alive filter paper tests are negative for traces of the dye in this fluid. The yellow colored yolk sac, the slate blue embryo in the clear amniotic fluid and the intensely stained allantois give a very beautiful and complete picture of the development and relations of the membranes.

If it is desired to preserve these demonstrations, a piece of glass suitable for mounting in a specimen jar should be placed in the bottom of the dish prior to removing the egg from its shell. The egg contents are oriented upon it and the water replaced with a solution of 10 per cent. formalin and 1 per cent. HCl; fixing for twenty-four hours. The albumen hardens and sticks to the glass, after which the preparation may be mounted in a solution of 4 per cent. formalin and 1 per cent. HCl.

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## DEMONSTRATING THE ASKENASY EXPERIMENT

AT the Kansas City meeting of the association a method of repeating the Askenasy experiment to show the raising of a column of mercury by evaporation from a water film as a classroom demonstration was described by Dr. B. E. Livingston. A similar method which has given superior results had been used for four years by me to demonstrate this principle to the classes in plant physiology at the University of Pennsylvania. The important requirements for success are:

(1) To boil the porous porcelain cylinder for several hours to remove all air.
(2) A perfectly clean glass tube which is filled with boiled water.
(3) A tightly seated rubber stopper.
(4) Clean mercury.

The glass tube is filled with boiled water by suction and it is attached to the clay cylinder while the latter is in the cooled boiled water. The water is held in the glass tube by closing with a clamp a piece of rubber tubing previously placed on the upper end (*i. e.*, before inversion) of the glass tubing.

Rises of over ten inches have been secured in an hour. The greatest total height recorded was twenty-eight inches after fifteen hours. A rise of twenty inches in several hours was not unusual when conditions favored rapid evaporation.

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[2] The capricious staining of the embryo by absorption of the dye from the allantoic fluid is still under investigation.

# SPECIAL ARTICLES

## DEWBOWS BY MOONLIGHT

DEWBOWS formed at night when light from a street lamp fell on small fog particles which had settled to the ground and retained their spherical form were observed by Knott and Lundie.[1] When the source of light was a gas lamp the bow was white, but when a more powerful electric lamp was used the rainbow tints were observed. The bows changed shape when either the horizontal distance from the observer to the source of light or the elevation of the observer's eye above the ground was changed, because the light from the lamp was divergent.

Maxwell[2] described a bow, seen at noon on an ice surface. This bow he attributed to water drops resting on the ice surface. Colors were present.

A. E. Heath[3] described a bow in the shape of a hyperbola produced by the sunlight on dew. This dew had settled on gossamer which covered a cricket field.

Several times during the past year, the writer has observed on the campus of the Rice Institute dewbows which differ from those described in the literature in that they were formed by moonlight shining on dew on a grassy surface. When the bows were seen the moon was always shining brightly from a position well above the horizon and the grass was wet with

[1] Proc. Roy Soc., Edinburgh, 1898.
[2] Proc. Roy. Soc., Edinburgh, 1870.
[3] *Nature*, 97, p. 5, 1916.

freshly formed dew. If the dew had been formed for more than a few hours no bows were seen, very probably because the increased size and weight of the drops caused an appreciable departure from perfect sphericity. The idea that it was necessary for the drops to be small was borne out by an observation made at 2 A. M., November 27. At this time a light shower had covered the grass with fairly large drops, which were by no means perfectly round. When the clouds had cleared away and the moonlight was very bright no indication of a bow could be seen.

The dewbows appeared as faintly defined streaks of white light tracing ellipses in the grass. The size and shape of the ellipses depended upon the angle of incidence of the moonbeams and the height of the observer's eye above the ground. The bow moved with the observer and different observers saw different bows.

We can calculate the size and shape a bow should have if it is formed by deviation through an angle $\beta$ of parallel light rays making an angle $\alpha$ with the horizontal. Take the stance of the observer as the origin and let the $x - y$ plane lie on the ground with the x-axis along the shadow of the observer. The beam AP is reflected to the eye of the observer E after being deviated through the angle $\beta$, so that the point P appears to be illuminated more strongly than the surrounding points. The locus of P is found as follows:

EB is a ray of incident light parallel to the ray AP. Draw PD and CD perpendicular to EB. Let h represent the height of the observer's eye above the ground. Then

$$BC = \frac{h}{\tan \alpha} - x; \quad CD = BC \sin \alpha$$

$$= h \cos \alpha - x \sin \alpha; \quad PC = y,$$

whence

$$PD = \sqrt{y^2 + h^2 \cos^2 \alpha - 2hx \cos \alpha \sin \alpha + x^2 \sin^2 \alpha};$$

$$PE = \sqrt{x^2 + y^2 + h^2}.$$

Thus

$$\frac{PD}{PE} = \sin \beta = \frac{\sqrt{y^2 + h^2 \cos^2 \alpha - 2hx \cos \alpha \sin \alpha + x^2 \sin^2 \alpha}}{\sqrt{x^2 + y^2 + h^2}}$$

from which we obtain

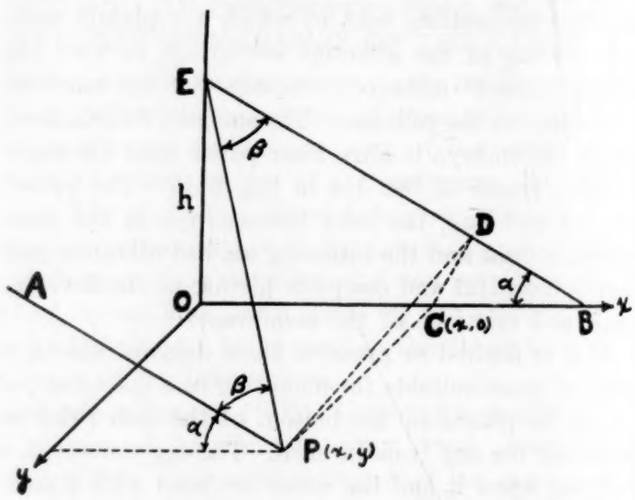
$$\frac{\left(x - \frac{h \cos \alpha \sin \alpha}{\sin^2 \alpha - \sin^2 \beta}\right)^2}{\left(\frac{h \sin \beta \cos \beta}{\sin^2 \alpha - \sin^2 \beta}\right)^2} + \frac{y^2}{\left(\frac{h \sin \beta}{\sqrt{\sin^2 \alpha - \sin^2 \beta}}\right)^2} = 1$$

This equation is seen to represent a circle when the angle $\alpha$ is 90°, an ellipse when $\alpha$ is between $\beta$ and 90°, a parabola for $\alpha = \beta$, and a hyperbola for $\alpha$ less than $\beta$.

All the bows observed were ellipses. It was possible to measure the lengths of the major and minor axes by having an assistant walk around the bow, this assistant, of course, being continually directed by the observer. The track left by the assistant in the dew was an ellipse and its axes could easily be measured. To calculate the lengths of the axes from the equation given above we may take $\beta = 42°$ and $h = 5.4$ ft. To get $\alpha$ the length of the shadow of a tall tower, of known height, was measured immediately after the assistant had traced out the dewbow in the grass. Results of this calculation are compared in the table below with the results of direct measurement for bows seen about 11:30 P. M., November 30 and December 1, 1925.

| | | Major axis (feet) | | Minor axis (feet) | |
|---|---|---|---|---|---|
| | $\alpha$ | Obs. | Calc. | Obs. | Calc. |
| Nov. 30 | 69.3° | 11 to 14 | 13.5 | 10 to 13 | 11.8 |
| Dec. 1 | 59.0° | 19 | 19.9 | 13 | 14.3 |

The agreement is as good as could be expected because the bows were not very sharply defined.

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## THE NATIONAL ACADEMY OF SCIENCES

(*Continued from page 506*)

*The acceleration of growth:* PROFESSOR THOMAS B. OSBORNE and LAFAYETTE B. MENDEL.

The factors which determine the possibility of growth may be classed, with respect to the organism involved, as internal or external in character. The internal factors include the real impulse to grow, of whatever nature it may be; in part they are inherited, they belong to the permanent biological characteristics of the individual. Heredity, with all that it involves, determines the most potent of these internal, constitutional incentives and conditions of growth. These are the determinants which are largely beyond our immediate control, yet must be reckoned with when defects of growth appear. The ex-

ternal factors, such as air, light, warmth, food, etc., that modify growth, on the other hand, are more amenable to directive regulation. The environment as well as the food of the individual can be modified more or less at will. Here, then, is a possible point of attack.

In the course of the past fifteen or more years we have had an opportunity to secure records of the rate of growth of several thousand rats under controllable conditions with respect to diet and environment. The animals have been bred from laboratory stock without any introduction of "new blood" within the past ten years. The stock diet during this period has presumably remained essentially the same so that changes in the average rate of growth may perhaps be properly attributable to the effects of selective breeding in the attempt to secure vigorous animals for experimental use. A noticeable increase in the average rate of growth has in fact resulted. For example, the average time required by male rats to grow from 60 gms. to 200 gms. body weight has gradually decreased; it was approximately 94 days in 1912; 89 days in 1913; 70 days in 1919; 67 days in 1925; the last rate of gain being somewhat better than that noted in the majority of records currently available. It represents at best the growth advantage secured through attention to inherent or hereditary factors.

From time to time we have observed instances of exceptionally rapid growth under conditions of diet and environment seemingly the same as those to which animals exhibiting the average rate of growth were subjected. This in itself indicates a *possibility* of largely accelerated growth that might be secured more generally if the underlying causes could be correctly ascertained. Chance observations indicated to us some time ago that diet may be concerned therein. Thus when a number of rats were placed upon a special ration that experience had suggested as more nearly "ideal," there resulted what seemed to be a "lesser variability" in the individual rates of growth; and the average for the period already referred to was decreased to 38 days. Subsequent experiments involving among other changes an increase in the protein content of the ration, particularly during the earlier period of growth, and the inclusion of liberal amounts of seemingly heterogeneous sorts of food materials, such as lettuce, liver or yeast, have promoted remarkably rapid gains in numerous instances. An outstanding illustration is afforded by rats—selected, it must be remembered, from our stock colony—that have grown from a body weight of 60 gms. to 200 gms. in less than 25 days, in contrast with approximately 70 days usually required by comparable animals. Records of these unusual accelerations of growth will be exhibited.

It need not be assumed that food itself determines the rate of growth; it merely gives the natural growth impulse fair play in a way that may not always have been recognized hitherto. The maximum size of animals growing at these accelerated rates is in general not unduly large, although frequently it has been decidedly larger than the average. The possibilities here involved raise numerous questions of both theoretical and practical interest. First of all, what is the nature of the chemical substances that may be responsible for the phenomena? Are we dealing with a more adequate supply of some essential that is ordinarily present in suboptimal proportions in the diet? Are there specific stimulants to growth? The effect that growth at highly increased rates may have upon the normal development of individual organs and the correlation of organ systems needs to be ascertained; likewise any influence upon the development of maturity, as represented by the capacity to breed. Indeed, it remains to be determined whether the maximal opportunity for the growth impulse may perchance lead to physiological detriment while chronological advantages are secured.

*Emotional stimulation of medulliadrenal secretion:* PROFESSOR W. B. CANNON and S. W. BRITTON.

In 1911 Cannon and de La Paz (1) reported that blood taken from the inferior vena cava, central to the openings of the lumbo-adrenal veins, in a cat which had been excited by a barking dog, gave a positive test for the presence of medulliadrenal secretion, whereas the test was negative in blood taken from the same region in the same animal before excitement. Although indirect evidence obtained by other investigators since then has indicated an increased secretion of adrenin in great emotional disturbance, and, although Hartman, McCordock and Loder (2), observing the reaction of the completely denervated iris, have reported some effects explicable as being due to increased secretion during excitement, the observations made in 1911 have not been directly confirmed. The failure of confirmation is mainly ascribable to difficulties in devising suitable methods.

Recently a method has been devised of complete denervation of the heart with survival of the animal (3). The denervated heart is affected by changes in the blood circulating through it. It is accelerated by the presence of secretion from the thyroid gland, from the liver and from the adrenal medulla. Removal of the stellate ganglia in denervating the heart also denervates the thyroid gland. If in addition the nerves to the liver are severed, the only remaining glands with known cardio-accelerating internal secretion are the adrenals. The denervated heart is extraordinarily sensitive to medulliadrenal secretion—it is made to beat faster when adrenin is present in the perfusing fluid in the ratio of one part to more than a billion (4). As a method for testing medulliadrenal secretion the heart separated from the nervous system and undergoing an internal perfusion has a number of advantages over other methods. Chief among them is the possibility of securing a continuous record, which reveals the latent period, the period of greatest response and the gradual subsidence of activity. The method also yields indication of the intensity of effect induced by various circumstances.

By use of the denervated heart as an indicator, we have studied the influence of different conditions on medulliadrenal secretion. Our results may be summarized as follows:

1. Even slight muscular activity, such as that involved in rising from a resting position, or in walking after being recumbent, is associated with an increase of heart rate. This does not occur after one adrenal gland is removed and the other denervated. It is remarkable that even with slight activity of the body there is concurrent discharge from the adrenal medulla.

2. Emotion, as evoked in a cat by the presence of a dog and as indicated by such signs of excitement as erection of hairs, showing of teeth, drawing back of the ears, hissing and snarling, is associated with increase of medulliadrenal secretion. In these reactions there is no movement of the large muscles. The increase of heart rate may not be much greater, however, than that which is seen after moderate activity. Nevertheless there is considerable variation in the response, and when the signs of sympathetic innervation (*e.g.*, erection of the hairs) are extreme, the evidence for coincident increased medulliadrenal secretion is more marked.

3. The denervated heart is extraordinarily accelerated when muscular activity is combined with emotional excitement. Whereas a change from a recumbent position to walking may increase the rate from 10 to 15 beats per minute and emotional excitement without noteworthy muscular activity may increase the rate about 20 beats per minute, the rage and struggle which the animal exhibits when tied to a holder, or the aggressive action with rage which the animal engages in when caged and barked at by a dog may accelerate the heart as much as 70 or 80 beats per minute. These reactions do not occur when the adrenal medulla is not functioning. After excluding medulliadrenal secretion, the increase of heart rate seen in such animals, kept alive and in normal health, was from 5 to 10 beats per minute. The acceleration of the heart, therefore, must have been due to increased secretion of adrenin.

The effects produced by emotional excitement accompanied by struggle are recovered from slowly. In one instance such activity lasting only a minute caused cardiac acceleration which did not subside until twenty-two minutes had passed.

The foregoing results indicate that control of the voluntary elements in an emotional response may remarkably lessen the degree of the bodily disturbance. They also show that there may be prolonged upsetting of the functions of the body as a consequence of emotional excitement.

*Calcium metabolism studies;* (A) *severe calcium disturbances and severe anemias produced by cultures from oral infections from patients with anemia;* (B) *calcium metabolism disturbances associated with active dental caries of childhood and pregnancy;* (C) *the raising of serum calcium by topical applications of raw and activated cod liver oil* (illustrated): WESTON A. PRICE (introduced by Victor C. Vaughan).

*The reddish-blue arcs and reddish-blue glow of the retina: Seeing your own nerve currents through bioluminescence:* CHRISTINE LADD-FRANKLIN (introduced by Henry H. Donaldson).

A simple band of bright red light thrown upon a screen in a dark room gives rise to a very curious phenomenon—discovered in the first instance by Purkinje. What you see on the screen is not only the red band, but also, projecting out from it on both sides, big slightly reddish blue arcs—they are not of the color of the visual purple, which is a slightly bluish red. If one considers the shape and the angular size of these arcs, it is perfectly plain that what one sees, as an entopic phenomenon, is certain fibers of the optic nerve which lie on the surface of the retina and which proceed to their exit point, the papilla. But why are they visible? The explanation that has been given of this phenomenon hitherto, by Gertz, by Troland and by others, is that the nerve current by which one sees the red band gives rise to a secondary induced current in adjoining nerve elements. Such a current as this, however, would not be provided with the right "place coefficients"—it would not enable one to see the stimulated fibers in the place where they lie. Various details of the phenomenon—the blue glow (which has been entirely overlooked by most observers), the after image, the absence of the effect in the case of individuals who have myelinated fibers in this region of the retina and other considerations—make it probable that the real cause is a bioluminescence on the part of the stimulated nerve fibers; the important work of Nodon (*Comptes rendus,* 1924) makes it very certain that this is what is actually taking place, and that in consequence all nerves when stimulated shine by their own light—a light which is invisible, of course, when the nerves are not non-myelinated.

*"The principle of minimum work II"—"The oxygen exchange in capillaries":* CECIL D. MURRAY (introduced by L. J. Henderson).

To what degree should blood be reduced in the tissue capillaries if, at constant metabolic rate, the process of oxygen transport is to be most efficient? If normal arterial blood is to be completely reduced, a capillary volume approaching infinity is theoretically required; if the reduction is infinitesimal, the rate of blood flow must approach infinity. An examination of this antagonism shows that normal operation of the circulation is characterized by a balance between the work of maintaining capillary blood volume and the work required to drive blood through the capillaries—a balance which makes the total work a minimum.

*Changes in the blood during exercise* (illustrated): L. J. HENDERSON, A. V. BOCK, D. B. DILL, L. M. HURXTHAL and J. S. LAWRENCE.

*The control of communicable diseases in the mobilization of armies:* VICTOR C. VAUGHAN.

*Experimental pellagra in rats:* JOSEPH GOLDBERGER and R. C. LILLIE (introduced by Victor C. Vaughan).

*Teletactile audition:* ROBERT GAULT (introduced by Victor C. Vaughan).